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ENVIRONMENTAL SAMPLING AND ANALYSIS PLAN
FOR CONSTRUCTION OF EPA LABORATORY AT
THE UNIVERSITY OF CALIFORNIA
RICHMOND FIELD STATION
Richmond, California

October 11, 1990

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October 11, 1990

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Region IX

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Richmond Field Station
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Appendix D	Total Threshold Limit Concentrations (TTLCs)
Appendix E	Nitrate Concentrations in Soils and Soil Solutions
Appendix F	Information on Wood Preservation Standards and Techniques

1.0 INTRODUCTION

This Sampling and Analysis Plan (SAP) has been prepared according to guidelines presented in the Preparation of U.S. EPA Region 9 Field Sampling Plan for Private and State-Lead Superfund Projects (EPA 1990).

This plan is organized into five major sections:

- Section 1: Introduction
- Section 2: Sampling Locations (Areas A, B, and C)
- Section 3: Sample Methods and Procedures
- Section 4: Data Quality Assessment
- Section 5: Laboratory Quality Assurance/Quality Control Procedures

Section 1 defines the purpose and scope of this study and the methodology used for preparation of the SAP, and includes a brief site description.

Section 2 describes potential contamination sources, summarizes studies conducted to date, identifies potential pollutants, and defines additional data needs.

Section 3 presents the sampling methods and procedures to be followed during sampling activities.

Section 4 discusses data quality assessment and presents the rationale for selection of the validation to be performed for this project.

Section 5 describes laboratory quality assurance/quality control procedures to be implemented during this investigation.

-
1. *Conduct field investigations as necessary to collect any additional data needed for the PHEE.*

D. Removal Action

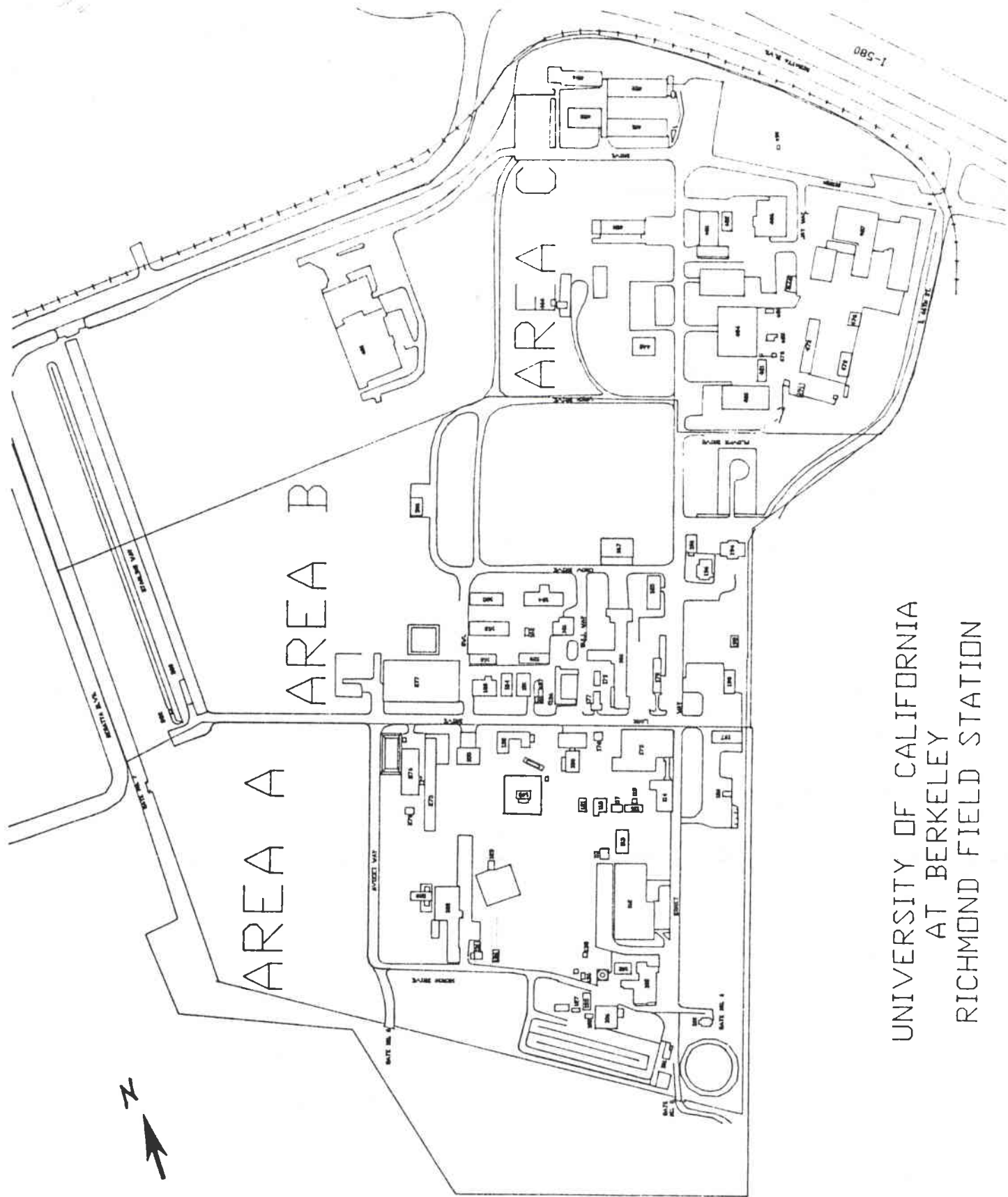
1. *Identify the appropriate cleanup criteria.*
2. *Perform an Engineering Evaluation/Cost Analysis.*
3. *Perform the Selected Removal Action.*
4. *Comply with State and Federal Superfund regulations in selecting and carrying out the response.*

Currently, A-1 is complete. Task A-2.1 is partially complete. Task B-1 is still in progress. Work on other tasks has not yet begun.

TABLE 1-2

List of Documents Reviewed

1. Jonas & Associates Inc., Removal Site Evaluation of Mercury in Soil and Groundwater at the Former Mercury Fulminate Facility, Richmond Field Station, May 1990.
2. Jones & Stokes Associates, Inc., Environmental Assessment for the Proposed EPA Region 9 Laboratory at the University of California's Richmond Field Station, Prepared for U.S. EPA, Region 9, April, 1990.
3. Ecology and Environment, Inc. (E&E), "Screening Site Inspection Reassessment," Prepared by Matthew Williams of E&E, Submitted to Paul La Courreye, Site Screening Coordinator, EPA Region IX, February 1990.
4. Ensco Environmental Services, Inc., Environmental Assessment of University of California, Richmond Field Station, Richmond, California, Prepared for Wallace Roberts & Todd, August, 1989.
5. Memorandum, from Mr. Bill Dost, Head WBRC RFS, to Mr. Larry Bill of RFS, subject: "Possible Soil Contamination Related to Wood Preservation Studies," July 7, 1989.
6. CH2M Hill, Technical Memorandum Summarizing Results of Environmental Sampling at the University of California, Richmond Field Station, December 6, 1988.
7. CH2M Hill, Technical Memorandum, Recommendation for Additional Environmental Sampling at the University of California Berkeley, Richmond Field Station, June 16, 1988.
8. ICF Technology Incorporated, Memorandum, From: Rick Dreessen, ICF Technology, Incorporated, to: Paul La Courreye, U.S. Environmental Protection Agency, Subject: Reassessment of the University of California, Richmond Field Station, Richmond, California, May 15, 1987.
9. Department of Health Services (DHS), "Hazardous Waste Surveillance and Compliance Report," 1982.
10. DHS, Letter reports and analytical results, 1981.



UNIVERSITY OF CALIFORNIA
AT BERKELEY
RICHMOND FIELD STATION

Figure 1-1 RFS Study AREAS



FIGURE 1-2
GENERAL MAP OF THE RFS PROPERTY AND ADJACENT AREAS

- Structural and Fire Test Laboratory
- Earthquake Simulator Laboratory
- Hydraulics and Coastal Engineering Center
- Soils Laboratory
- Forest Products Laboratory
- Northern Regional Library Facility
- Asbestos Information Center

Five small machine/maintenance shops are located within Buildings 125, 175, 277, 450, and 478. Liquid and solid wastes generated at these sites are stored in drums and transported offsite to a permitted treatment/storage/disposal facility. RFS has a team of personnel responsible for hazardous materials management and environmental compliance at the facility.

Currently, there is one underground gasoline storage tank at RFS. On March 7, 1988 a groundwater monitoring well was installed near this tank. Groundwater samples were collected to test for the possible presence of nonhalogenated hydrocarbons. Chemical analysis indicated that the nonhalogenated hydrocarbon concentrations in the groundwater ranged from below instrument detection levels for benzene, ethylbenzene, and total petroleum hydrocarbons (TPH - quantified as gasoline) to 0.6 micrograms per liter (ug/l) for xylene and 6.6 ug/l for toluene. The State of California, Department of Health Services (DHS) drinking water action levels for xylene and toluene are 620 and 100 ug/l, respectively. The maximum contaminant level (MCL) for xylene is 1.750 mg/l (milligrams per liter). There is no MCL for toluene. The detected levels are well below the action levels and MCLs. Therefore, these detected concentrations are not of concern. RFS has a maintenance and monitoring system in place. Any significant leaks will be identified by the monitoring system.

In the past, RFS had four additional underground diesel fuel tanks. These tanks were removed in 1986 according to tank removal procedures specified by the Contra Costa County, Department of Environmental Health Services.

2.0 SAMPLING LOCATIONS

Appendix A summarizes past sampling activities conducted by DHS, CH2M Hill and J&A and includes the sampling date, analyses requested, and analytical results. As previously discussed, RFS has been divided into three separate areas (A, B, and C). Potential

- Structural and Fire Test Laboratory
- Earthquake Simulator Laboratory
- Hydraulics and Coastal Engineering Center
- Soils Laboratory
- Forest Products Laboratory
- Northern Regional Library Facility
- Asbestos Information Center

Five small machine/maintenance shops are located within Buildings 125, 175, 277, 450, and 478. Liquid and solid wastes generated at these sites are stored in drums and transported offsite to a permitted treatment/storage/disposal facility. RFS has a team of personnel responsible for hazardous materials management and environmental compliance at the facility.

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pollutant sources have been identified, (see Plate 1-1; Appendix C), and are discussed below. A summary of proposed sampling activity is provided in Section 3.0 of the SAP.

2.1 AREA A - SOUTH-SOUTHEAST AREA OF RFS

Area A is located in the south-southeastern portion of RFS. It covers approximately 75 acres and, for the purposes of this SAP, it has been divided into four sections:

1. Former mercury fulminate facility and shell manufacturing area.
2. Marsh area.
3. Vacant land northwest of Avocet way.
4. Buildings 118, 120, 121, 150, and 197.

A description of each section, summary of past sampling investigations conducted for each area, potential contaminants present, and additional data needs are described below.

2.1.1 Former Mercury Fulminate Facility and Shell Manufacturing Area

2.1.1.1 Description

The former CCC's mercury fulminate facility is located in the southeastern portion of RFS. The site of the former mercury fulminate facility is currently occupied by Buildings 136 and 138. Mercury fulminate, produced at the former mercury fulminate facility, is a chemical mixture of alcohol, nitric acid, and mercury. It is highly explosive and is used chiefly for the percussion caps on shells and cartridges.

Building 128 is the site of what has been referred to in various reports as the shell manufacturing area. A Sanborn Fire Insurance Company map for this area (1930 - 1950) shows the Building 128 location identified as "CHINA PRESS HO." A small portion of the area is identified as "CAP Storage." Based on the available information, it is not clear what activities were performed at this facility. No evidence of shell manufacturing activity could be established. However, to be consistent with the previous reports, reference to this area as the shell manufacturing area will continue.

2.1.1.2 Summary of Past Sampling and Analysis

In 1981, DHS collected one soil sample near Building 128. Although the exact analytical methods and quality control measures followed are not known, available data indicate that mercury was detected in soil at a concentration of 105 milligrams/kilogram (mg/kg) (DHS 1981). In 1982, DHS collected three additional soil samples from this area (Plate 1-1; Appendix C). These samples, identified as SS009B, SS010A, and SS010C, were analyzed for metals (DHS 1982). Mercury was not detected in any of the samples. Other metal concentrations in the soil samples were below DHS Total Threshold Limit Concentrations (TTLC). Appendix D contains a list of metals and their corresponding TTLC levels.

In discussions with personnel at the DHS Hazardous Materials Laboratory (Iskander 1990) J&A was informed that the analytical mercury results for samples collected in 1982 by DHS may be questionable due to inadequate methods and analytical detection levels used eight years ago. However, proper methods were applied for all the other metals. Therefore, the mercury results for 1982 will be considered unacceptable, but the results for the other metals detected will be considered adequate for the purposes of this investigation.

In 1988, CH2M Hill (CH2M Hill 1988) collected additional samples at this location. The purpose of their investigation was to follow up on previous sampling activities and to supplement and/or clarify analytical results. During this investigation one composite soil sample was compiled from three locations in the general area of the former mercury fulminate facility. These sample locations are identified as SI-1, SI-2, and SI-3 on Plate 1-1 (Appendix C). The composite soil sample was analyzed for metals, pesticides, and polychlorinated biphenyl (PCB). Metals, pesticides and PCBs were not detected above analytical method detection limits.

In order to conduct a more detailed assessment of the mercury contamination in soil in the general area of the mercury fulminate facility and shell manufacturing area, RFS initiated the phased RSE-EE/CA investigation. In December 1989, J&A was retained to begin Phase I of the RSE-EE/CA investigation. The scope of work for Phase I of the investigation consisted of the following tasks:

- Define the horizontal extent of mercury in soil from 0 - 3 feet in depth range.
- Determine the concentration of mercury in surface soil samples collected in the 0 - 3 inches range.

- Determine whether levels of mercury in soil exceed the designated federal and state hazardous waste levels.
- Determine if mercury is present in underlying groundwater.
- Collect and analyze soil samples for nitrate.
- Collect and analyze soil samples for sulfate.
- Collect and analyze soil samples for copper and zinc.

From December 1989 through February 1990, four rounds of soil sampling were performed by J&A. Plate 1-1 (Appendix C) shows sampling locations. This investigation included collection of 147 discrete soil samples (0 - 3 feet) collected from 47 boreholes; analysis of 49 composite soil samples for mercury; analysis of 4 composite soil samples for sulfate, nitrate, copper and zinc; and collection and analysis of 10 surface soil samples (0 - 3 inches) for mercury. Two soil samples were also analyzed for mercury using the Extraction Procedure (EP Toxicity) and Waste Extraction Tests (WET) extraction procedures. In addition, one groundwater monitoring well was installed and groundwater was sampled and analyzed for mercury. A total of four additional composite soil samples were collected from the monitoring well borehole and analyzed for mercury.

The methodology and findings of this study are included in a J&A report entitled Preliminary Investigation of Mercury in Soil and Groundwater at Former Mercury Fulminate Facility, Richmond Field Station (J&A 1990a). The results of this investigation indicated that mercury is present in the soil above the TTLC level in the area of the former mercury fulminate facility. Mercury was not detected above the TTLC level in the former shell manufacturing area.

Two composite samples collected in the former mercury fulminate facility area were analyzed for mercury using the EP Toxicity and WET extraction methods. Mercury was detected [Boring B-18: 1.3 milligrams per liter (mg/l)] above the Soluble Threshold Concentration Level (STLC: 0.2 mg/l) using the WET extraction method. Mercury was not detected in the soil sample (Boring B-21) that was analyzed using the EP Toxicity extraction method. No mercury was detected in the groundwater sample analyzed. Copper and zinc were present in the soil below TTLC levels, and sulfate and nitrate were detected in soil in low concentrations.

2.1.1.3 Potential Contaminants and Additional Data Needs

2.1.1.3.1 Potential Contaminants

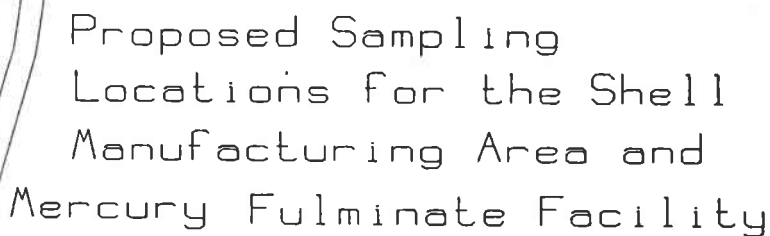
Mercury fulminate has a chemical formula of $\{Hg-(ONC)_2 \text{ or } C_2N_2 O_2Hg\}$, a molecular weight of 284.6, and a density of 4.42 g/cm^3 . It contains nitrogen at 9.84%. Based on the chemical formula of mercury fulminate, mercury and nitrite/nitrate are the two contaminants that may be expected to be present in the former mercury fulminate area. Mercury fulminate is also described as mercury cyanate, $Hg(CNO)_2$. Therefore, it is possible that cyanide may be present in the former mercury fulminate area.

2.1.1.3.2 Additional Data Needs

Extensive investigation of mercury in soils has been conducted in Area A (Plate 1-1; Appendix C). Additional studies will be conducted at this portion of the property. Figure 2-1 denotes proposed soil sampling locations. Sampling will be conducted in order to confirm 1981 DHS sampling results (105 mg/kg of mercury near former shell manufacturing area) and complete the existing grid pattern (approximately 75 by 60 foot grid pattern). Sixteen soil samples and three duplicate samples (0.5 to 1.5 feet) will be collected from the former shell manufacturing and mercury fulminate areas and analyzed for the Target Analyte List (TAL) of 22 metals. Two of the samples collected from the areas where high concentrations of mercury were detected during J&A's previous study, will also be analyzed for cyanide.

A phased approach in defining the vertical extent of soil contamination will be taken. Initially, profiling will be done at two boreholes at a total depth of 15 feet. These boreholes will be drilled in areas where a high concentration of mercury was detected during J&A's previous study. Discrete soil samples will be collected every 2.5 feet (a total of five samples per borehole) and analyzed for TAL metals. From this initial investigation, the actual depth necessary for future soil characterization will be used to define the second phase of vertical sampling.

This SAP includes the scope of work for the first phase of this investigation. As previously discussed in Section 1.1.3, the approach to vertical sampling will be phased. Four working days after the receipt of the analytical results of the first phase, a proposal and a scope of work for the second phase will be prepared and submitted to EPA for review and approval as an addendum to this SAP. The second phase will commence one week after EPA's approval of the revised scope of work (see Table 1-1).



The rationale for selection of specific sampling locations and analytical parameters for the first phase of the investigation is provided in Table 2-1.

TABLE 2-1 Rationale for Proposed Sampling - Shell Manufacturing Area and Mercury Fulminate Facility

SAMPLE NUMBER	SAMPLE DEPTH AND ANALYSIS	RATIONALE FOR LOCATION	RATIONALE FOR ANALYSIS
B1SH-101590 through B13SH-101590 and B16SH-101590	0.5 - 1.5 feet Analysis: TAL metals	Completing the existing grid pattern of approximately 75 by 60 feet.	To determine the extent of soil contamination.
B14SH-101590 and B18SH-101590 (duplicate of B14SH-101590)	0.5 - 1.5 feet Analysis: TAL metals and cyanide	Previously the second highest concentration of mercury detected at the former shell manufacturing area was present in samples collected from this location.	To determine if cyanide and metals are parameters of concern.
B15SH-1.5-101590 B17SH-101590 (duplicate of B15SH-1.5-101590)	0.5 - 1.5 feet Analysis: TAL metals and cyanide	Previously the highest concentration of mercury detected at the former shell manufacturing area was present in samples collected from this location.	To determine if cyanide and metals are parameters of concern.
B15SH-4-101590 through B15SH-14-101590	Discrete soil samples every 2.5 feet. Analysis: TAL metals	Same as above.	To determine the vertical extent of soil contamination.
B1MF-101590	0.5 - 1.5 feet Analysis: TAL metals and cyanide	This area was selected because during previous investigations the second highest concentration of mercury was detected at this location.	To determine if cyanide and metals should be contaminants of concern.

TABLE 2-1 (Continued)

SAMPLE NUMBER	SAMPLE DEPTH AND ANALYSIS	RATIONALE FOR LOCATION	RATIONALE FOR ANALYSIS
B2MF-1.5-101590 B3MF-101590 (duplicate of B2MF-1.5-101590)	0.5 - 1.5 feet Analysis: TAL metals and cyanide	Previously the highest concentration of mercury detected at the former mercury fulminate area was present in samples collected from this location.	To determine if cyanide and metals are contaminants of concern.
B2MF-4-101590 through B2MF-14-101590	Discrete soil samples every 2.5 feet. Analysis: TAL metals	Same as above.	To determine the vertical extent of soil contamination.

It was recommended that the following additional tasks be incorporated into Phase II of the RSE-EE/CA mercury contamination investigation.

- Conduct field investigations to collect the site-specific data necessary to meet the overall mercury investigation objectives.
- Conduct a preliminary Public Health and Environmental Evaluation (PHEE).
- Using information developed by the PHEE provide a quantitative basis for selection of an appropriate removal action.
- Continue groundwater sampling and analysis.

In several reports referenced in Table 1-2, analysis of soil samples for nitrate was suggested. As mentioned above, four soil samples were analyzed for nitrate. Nitrate was detected in Area A at a concentration range of 11 to 44 mg/kg. According to a report published by National Academy of Sciences (1978), nonfertilized fallow soils often have 5 to 10 mg/kg of $\text{NO}_3\text{-N}$ in winter and around 50 mg/kg in spring and summer, while organic soils may have several hundred mg/kg nitrate. High concentrations of nitrate also are found in the vicinity of banded fertilizer application zones. Appendix E lists nitrate concentrations in a variety of soils. Based on the referenced report, nitrate concentrations detected at the former mercury fulminate and shell manufacturing areas are within the normal soil concentration ranges. Even though nitrate may be one of the suspected pollutants, it is unknown whether the nitrate found represents a free radical of nitroglycerin or is from another anthropogenic source (garden fertilizer or sewage). Since

the nitrate concentrations detected are within the normal soil concentration ranges, additional analysis for nitrate is not recommended.

The lateral composite soil sample collected by CH2M Hill was analyzed for metals, pesticides, and PCBs. Pesticides and PCBs were not detected above analytical method detection limits. The concentrations of the metals detected were below corresponding TTLCs. Copper and zinc analyses by J&A also showed concentration levels below corresponding TTLC levels. Further analysis for pesticides and PCBs will not be performed as part of this proposed sampling and analysis. However, based on EPA's request, all soil samples collected will be analyzed for TAL metals.

Volatile organic compounds are not suspected pollutants, because there is no indication that solvents were used in this area. In addition, any activities that may have resulted in release of volatile organic compounds ceased approximately forty-five years ago. Therefore, analysis for volatile organic compounds is not recommended.

2.1.2 Marsh Area

2.1.2.1 Description

Approximately 30 acres of salt marsh are located southeast of RFS. Parts of the salt marsh have been filled by both UC and the CCC. The salt marsh was divided in 1959 by the construction of the Santa Fe Railroad embankment. The construction of the rail line was the result of a 1943 easement granted to the Santa Fe Land Improvement Company by CCC. UC, upon purchase of RFS, took over the easement agreement. This rail line connected the post office on Pt. Isabel to Marina Bay, and was in use until the early 1980s. The rail line has been partially torn up and the right-of-way is planned to become part of a trail around the Bay (Mikklesen 1989).

According to a report prepared by Dr. Joyce Gutstein (1989a) another change made in the marsh was the demolition of a section of an old pier. The pier had been in existence since at least 1899 and originally extended from the shore to the slough. In its earlier history it was used for the unloading of barges to a narrow gauge rail line which terminated at the pier. The inner marsh portion of the pier was demolished by the UC in 1976 and replaced with a road. The road was then moved to its present location to comply with Bay Conservation and Development Commission requirements. The onsite Sanitary Engineering Environmental Health Research Laboratory (SEEHRL) uses the pier and a small pumping station at the end of the pier for the pipeline which transports baywater from an offshore platform to SEEHRL. No other structures are present in the marsh.

2.1.2.2 Summary of Past Sampling and Analysis

In 1981, DHS collected one soil sample from the marsh area (Sample # 6) at a depth of no greater than one foot. The sample was analyzed for metals. Mercury was detected at a concentration of 23 mg/kg. According to a report written by ICF Technology (1987), during this investigation a composite soil sample collected from six separate locations in the marsh area showed DDT concentrations of 1.7 mg/kg.

DHS indicates that two of the soil samples collected during the 1982 sampling event were also analyzed for DDT, DDD, and DDE in addition to metals. One soil sample was collected from the marsh area. The location of the other sample is not clear. Based on the 1982 DHS investigation, DDT, DDD, and DDE were not detected above instrument detection limits of 0.3, 0.2 and 0.2 micrograms per kilogram (ug/kg), respectively. Detected metal concentrations were below TTLC levels.

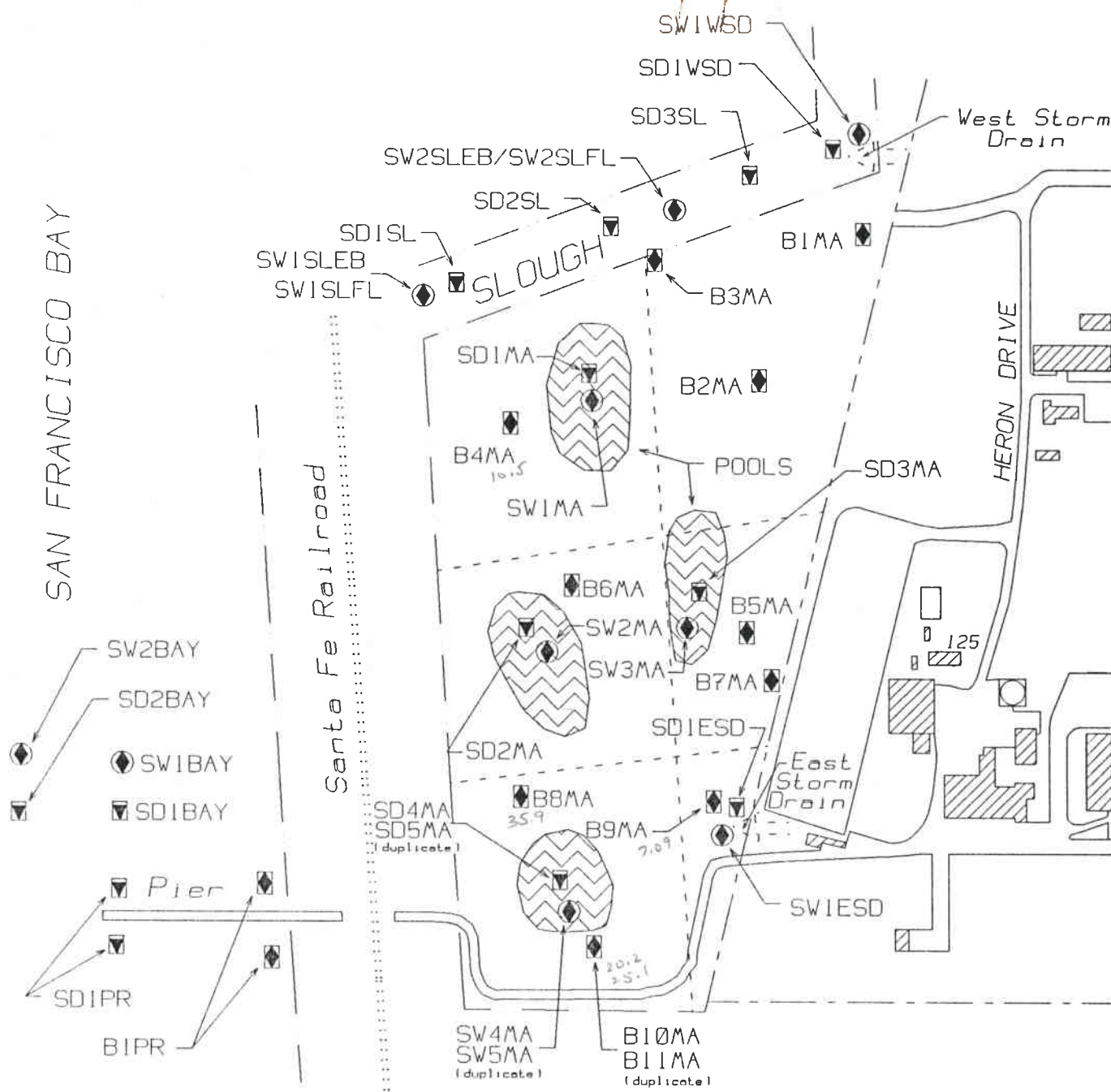
2.1.2.3 Potential Contaminants and Additional Data Needs

2.1.2.3.1 Potential Contaminants

According to ICF's report, the DHS 1981 sampling results indicate mercury and DDT may be present in the marsh area.

2.1.2.3.2 Additional Data Needs

The marsh has been impacted by previous activities. The Bay Area Regional Water Quality Control Board (RWQCB) is concerned with the overall quality of the Richmond Inner Harbor. In order to assess the extent of contamination at the marsh area, ten discrete soil samples and one duplicate will be collected from the marsh area based on a 200 by 100 foot grid pattern. Soil samples will be collected at a depth range of 0.5 to 1.5 feet below the ground surface. Four surface water samples and one duplicate and four submerged sediment samples and one duplicate will be collected from the four surface water "pools" currently located in the marsh area. One drainage water and one submerged sediment sample will be collected from each of the east and west storm drains. Three sediment samples will be collected from the slough running northwest by southeast of the RFS, near the marsh area. Four surface water samples (two flood tide and two ebb tide) will also be collected from this slough. Two surface water and two sediment samples will be collected from the Bay. One lateral composite sediment sample will be collected from two locations at the submerged end of the pier. One composite soil sample will be collected from two locations at the exposed end of the former pier. All samples will be analyzed for TAL metals. Two of the marsh samples located northeast of the marsh, and two of the samples located northwest of the marsh, will also be analyzed for pesticides in order to determine if the marsh area has been impacted by offsite sources (see Figure 2-2). Table 2-2 presents the rationale for selection of sample locations and analytical parameters.

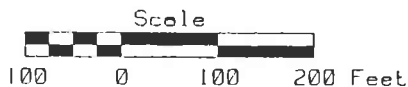


Legend:

Proposed Samples:

- ◆ Soil
- ▣ Submerged Sediment
- Surface Water

Proposed Sampling
Locations - Marsh.
Slough. East and
West Storm Drains.
Marsh and Bay



Prepared by
JONAS & ASSOCIATES

Date: 9-30-1990
Scale as shown

Figure 2-2

Drawing Number
90-101-S4422

TABLE 2-2 RATIONALE FOR PROPOSED SAMPLING - MARSH, SLOUGH AND BAY

SAMPLE NUMBER	SAMPLE DEPTH AND ANALYSIS	RATIONALE FOR SAMPLE LOCATION	RATIONALE FOR ANALYSIS
<u>SURFACE SOIL - MARSH</u>			
B1MA-101590	0.5 - 1.5 feet Analysis: TAL metals	Adjacent to the previous soil sample collected on the other side of the fence.	Determine the extent of soil contamination.
B2MA-101590	Same as above.	Center of the grid.	Same as above.
B3MA-101590	Including the above plus pesticides.	Between the Slough and the Marsh.	Determine the extent of soil contamination closer to the Slough.
B4MA-101590	0.5 - 1.5 feet Analysis: TAL metals	Center of the grid.	Determine the extent of soil contamination.
B5MA-101590	Same as above.	Same as above.	Same as above.
B6MA-102090	Same as above.	Since the center of the grid may be occupied by water, this sample will be collected at a location near the center of the grid.	Same as above.
B7MA-101590	Same as above.	Adjacent to the previous soil sample collected on the other side of the fence.	Same as above.

TABLE 2-2 (Continued)

B8MA-101590 and B10MA-101590 B11MA-101590 (duplicate of B10MA-101590)	0.5 - 1.5 feet Analysis: TAL metals, and pesticides.	Since this is a larger square, two soil samples, one from the northwest and one from the southeast section of the square will be collected.	To determine the extent of soil contamination. Also to determine whether the marsh has been impacted by off-site sources.
B9MA-101590	Same as above.	Center of the grid.	Same as above.
<u>SUBMERGED SEDIMENT - MARSH</u>			
SD1MA-101590 through SD4MA-101590	Surface (0.5 feet) Analysis: TAL metals	Four pools currently located in the marsh.	To determine the extent of submerged sediment contamination.
<u>SURFACE WATER - MARSH</u>			
SW1MA-101590 through SW4MA-101590	Surface water. Analysis: TAL metals	Four pools currently located in the marsh.	To determine the extent of surface water contamination.
<u>SUBMERGED SEDIMENT - STORM DRAINS</u>			
SD1WSD-101590	Surface sediment from the West storm drain. Analysis: TAL metals	West storm drain.	To determine the extent of contamination.
SD1ESD-101590	Surface sediment from the East storm drain. Analysis: TAL metals	East storm drain.	Same as above.

TABLE 2-2 (Continued)

<u>SURFACE WATER - STORM DRAINS</u>	SW1WSD-101590	Surface water from the West storm drain. Analysis: TAL metals	West storm drain.	To determine the extent of contamination.
	SW1ESD-101590	Surface water from the East storm drain. Analysis: TAL metals	East storm drain.	Same as above.
<u>SURFACE WATER - SLOUGH</u>	SW1SLEB-DATE	Surface water samples. Analysis: TAL metals	Surface water during ebb tide, at the southern end of the slough.	To evaluate the water quality status at the southern end of the slough.
	SW1SLFL-DATE	Same as above.	Surface water during flood tide, at the southern end of the slough.	Same as above.
	SW2SLEB-DATE	Same as above.	Surface water during ebb tide, as the northern end of the slough.	To evaluate the water quality at the northern end of the slough.
	SW3SLFL-DATE	Same as above.	Surface water during flood tide, at the northern end of the slough.	Same as above.

TABLE 2-2 (Continued)

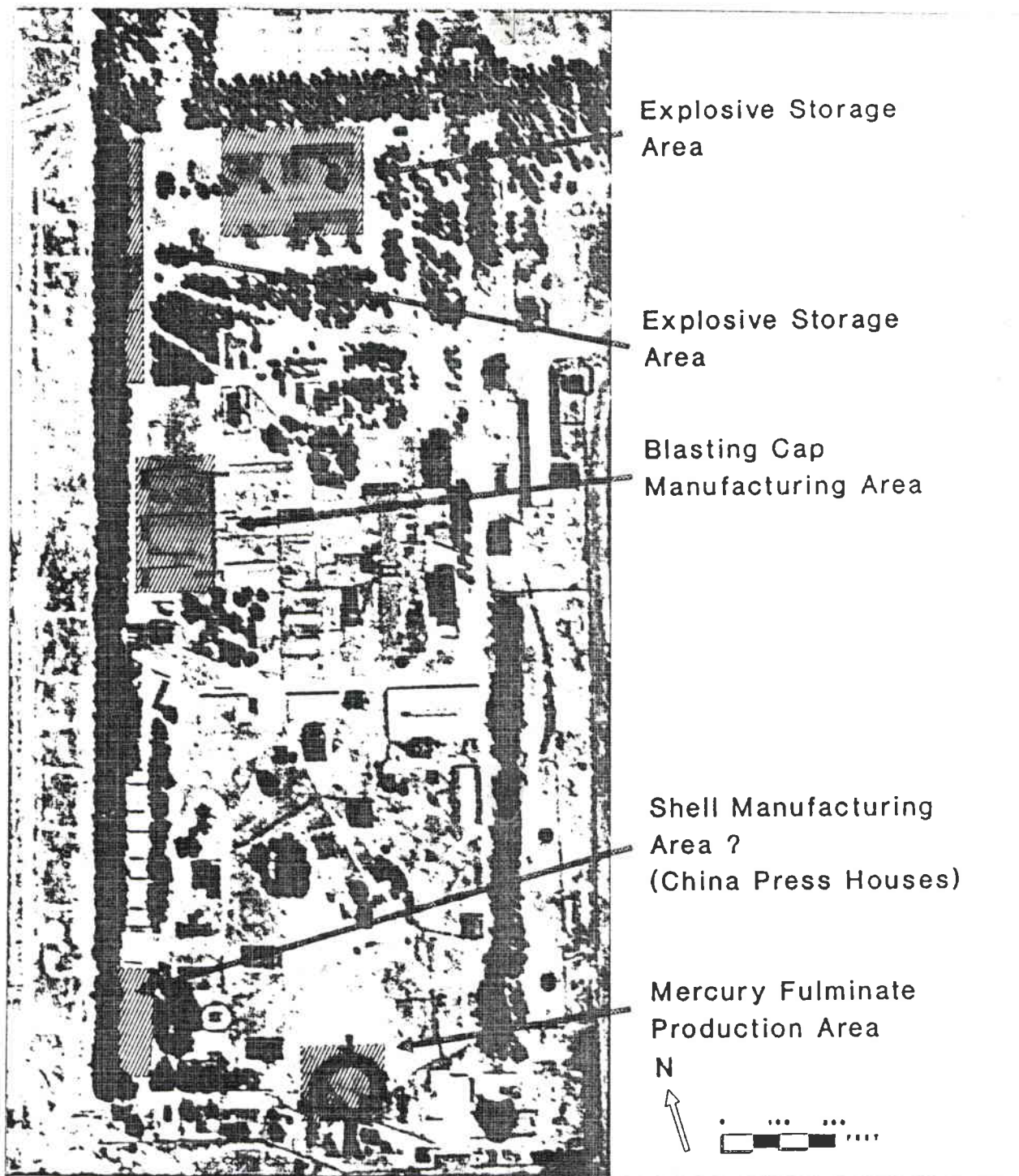
<u>SUBMERGED SEDIMENT - SLOUGH</u>			
SD1SL-101590	Sediment sample at the southern end of the slough. Analysis: TAL metals	Sediment sample at the southern end of the slough.	To determine if contaminated.
SD2SL-101590	Sediment sample located between the samples collected from the two ends of the slough.	Determine extent of potential contamination (if any).	To determine if contaminated.
SD3SL-101590	Same as above.	Sediment sample at the northern end of the slough.	Same as above.
<u>SURFACE SOIL - PIER</u>			
B1PR-101590	Lateral composite, 0.5 - 1.5 feet at two locations from exposed end of pier. Analysis: TAL metals	To determine if impacted by activities at RFS.	To determine if impacted by activities at RFS.
<u>SUBMERGED SEDIMENT - PIER</u>			
SD1PR-101590	Lateral surface composite sample from the end of the pier that is submerged. Analysis: TAL metals	To determine if impacted by activities at RFS.	To determine if impacted by activities at RFS.

2.1.3.1 Description

Approximately 6 acres of open space are located northwest of Avocet Way. Based on a 1946 aerial photograph (Figure 2-3), and a Sanborn Fire Insurance Company map of the area (1930 - 1950), it appears this area has always been vacant.

2.1.3.2 Summary of Past Sampling and Analysis

In 1988, six soil samples were collected from this area by CH2M Hill. The locations of these samples are identified as S2-1 through S2-3 and S3-1 through S3-2 on Plate 1-1 (Appendix C). The S2 and S3 series of samples were each composited separately.



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FIGURE 2-3
1946 AERIAL PHOTOGRAPH
OF RICHMOND FIELD STATION

The resulting composite soil samples were then analyzed for metals (including mercury), pesticides, and PCBs. Metals were detected below TTLC levels. Pesticides and PCBs were not detected.

2.1.3.3 Potential Contaminants and Additional Data Needs

2.1.3.3.1 Potential Contaminants

Based on a 1946 aerial photograph (Figure 2-3), this area has always been vacant. Consequently, there are no sources of soil contamination. In addition, previous sampling has revealed no soil contamination.

2.1.3.3.2 Additional Data Needs

No additional data needs have been identified.

2.1.4 Buildings 118, 120, 121, 150, and 197

2.1.4.1 Description

Small amounts of chemicals have been stored outside Buildings 118, 120, 121, 150, and 197. Information regarding the past and current chemical usage and storage at these buildings is provided in Table 2-3. On September 19, 1990, J&A conducted a site visit of these buildings. The purpose of the site visit was to interview facility personnel familiar with the chemical/waste storage and disposal activities at these buildings and to identify any areas that might require characterization.

During the site visit several areas of surface soil discoloration were observed. The discoloration consisted of black staining in all cases and no greater than two stained areas were observed per building. These stains corresponded with previous temporary drum storage areas adjacent to Buildings 118, 120, and 121.

2.1.4.2 Summary of Past Sampling and Analysis

No previous soil sampling has been conducted near these buildings.

TABLE 2-3 USE OF HAZARDOUS MATERIALS AT BUILDINGS 118, 120, 121, 150, AND 197

BUILDING	CHEMICALS USED	CHEMICALS STORED	COMMENT
Building 118	Kerosene	Kerosene	Currently there is one drum of kerosene onsite which is used as fuel. Two 55-gallon drums were stored on the east side of Building 118. A small area of stained soil was observed in this area during the site visit.
Building 120	None	Over the years, the area has been used for temporary storage of drums containing chemicals such as thinner (mineral spirits), kerosene, and various petroleum hydrocarbon products.	This area is covered with gravel and is used as a temporary drum storage area. A small stained area in the drum storage area was observed during site visit.
Building 121	Diesel fuel	Diesel fuel	At one time there was a 55 gallon above ground diesel fuel storage tank. The tank has since been removed. Currently, there are no chemicals stored here. There have been no reported spills in this area. However, during the site inspection a small area of stained soil was observed near Building 121.

TABLE 2-3 (Continued)

BUILDING	CHEMICALS USED	CHEMICALS STORED	COMMENT
Building 150	None	None	Empty drums have been stored here in the past. No sign of stained soils was observed in this area.
Building 197	None	Various drums gathered from all over the facility were temporarily stored behind Building 197 prior to proper sampling and disposal.	There have been no reported spills at this location. No stained soils were observed in the area.

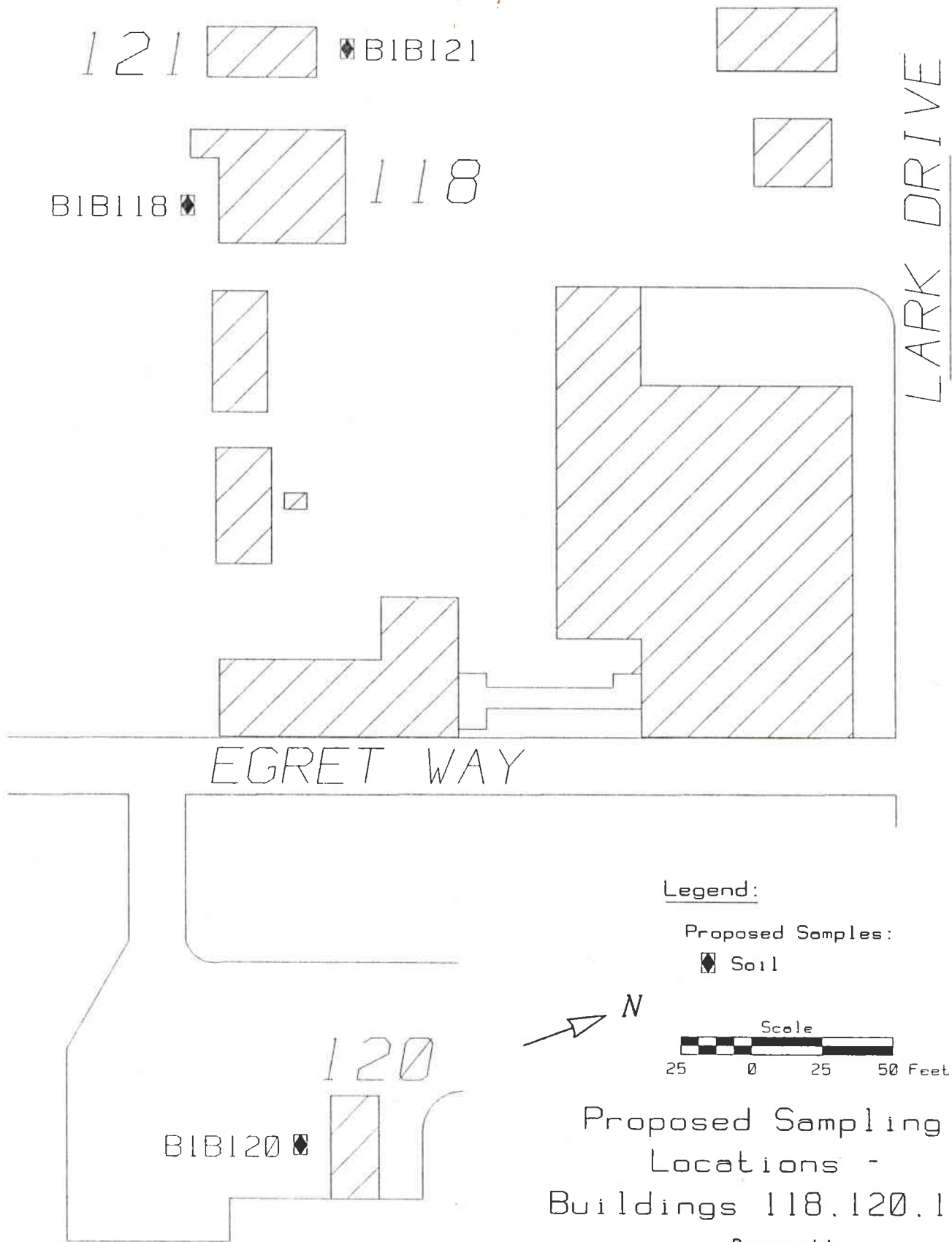
2.1.4.3 Potential Contaminants and Additional Data Needs

2.1.4.3.1 Potential Contaminants

During J&A's site visit stained surface soil was observed near Buildings 118, 120, and 121. Based on the information provided by RFS personnel, kerosene may be the chemical of concern near Building 118; thinner (mineral spirits), kerosene, and petroleum hydrocarbons near Building 120; and diesel fuel near Building 121.

2.1.4.3.2 Additional Data Needs

Collection and analysis of one discrete soil sample per location is recommended for the stained soil areas near Buildings 118, 120, and 121 (see Figure 2-4). Since diesel and kerosene waste are excluded from federal regulations under 40 CFR, Part 261 and 262, State requirements will be followed with respect to the required analyses. The soil samples will be analyzed for Total Extractable Hydrocarbons (EPA Method Number 8015) and Total Volatile Hydrocarbons (TVH) with Benzene, Toluene, Xylene and Ethyl Benzene (BTX&E) (EPA Method 8015 modified/8020) to assess any potential soil contamination that may be present as a result of previous chemical storage activities. Table 2-4 summarizes the rationale for the selection of proposed soil sampling locations and analytical parameters at Buildings 118, 120 and 121.



Proposed Sampling
Locations -
Buildings 118, 120, 121

Prepared by
JONAS & ASSOCIATES

Date: 9-30-1990
Scale as shown

Figure 2-4

Drawing Number
90-101-S4424

TABLE 2-4 RATIONALE FOR PROPOSED SAMPLING - BUILDINGS 118, 120 and 121

SAMPLE NUMBER	SAMPLE DEPTH and ANALYSIS	RATIONALE FOR SAMPLE LOCATION	RATIONALE FOR ANALYSIS
B1B118-101590	0.5 - 1.0 feet. Analysis: TEH EPA 8015, TVH EPA 8015 and BTX&E EPA 8020.	Stained soil	Kerosene is being used at this building.
B1B120-101590	Same as above.	Same as above.	Kerosene and various petroleum hydrocarbons are being stored at this building.
B1B121-101590	Same as above.	Same as above.	Diesel fuel was stored in an above ground tank outside this building.

2.2 AREA B - CENTRAL AREA OF RFS

Area B is located in the central portion of RFS. It covers approximately 20 acres, and for the purposes of this SAP it is divided into four sections:

1. Former explosive storage area south of Crow Drive and north of Wern Drive.
2. Former test pit area.
3. Former blasting cap manufacturing area located south of Crow Drive and north of Lark Drive.
4. Vacant land northeast of Regatta Boulevard.

A description of each section, summary of past sampling investigations, potential contaminants present, and additional data needs are described below.

2.2.1 Former Explosive Storage Areas

2.2.1.1 Description

The former explosive storage areas are identified on Plate 1-1 (Attachment C). Currently these areas are vacant lots.

2.2.1.2 Summary of Past Sampling and Analysis

In 1981, DHS collected two soil samples from the explosive storage areas located at the intersection of Wren Drive and Egret Way (see Plate 1-1: Attachment C). According to the ICF study these samples were analyzed for metals and DDT. Levels of metals detected did not exceed corresponding TTLC levels, and DDT was not detected above method detection limits.

In 1982, DHS collected six additional soil samples from both of the explosive storage areas. These samples were analyzed for metals. Metal concentrations for all samples were below TTLC levels. Mercury was not detected in any of the samples. Based on the discussion presented in Section 2.1.1.2 of the SAP, the mercury results are unacceptable.

2.2.1.3 Potential Contaminants and Additional Data Needs

2.2.1.3.1 Potential Contaminants

Metals, specifically mercury, may be present in soils at these areas.

2.2.1.3.2 Additional Data Needs

Fifteen soil samples and one duplicate will be collected from the former explosive storage areas. Twelve of these samples will be collected from the larger explosive storage area adjacent to Wren drive. Based on a gridded pattern, one sample from every other square (a total of six samples) and one duplicate sample will be selected for the initial analysis.

These samples will be analyzed for TAL metals. If metals are detected above background, then the other six samples will be tested for the same set of parameters.

Otherwise, the initial six samples will be considered adequate and additional analyses will not be performed.

Three of the fifteen soil samples will be collected at the smaller explosive storage area (see Figure 2-5). All three samples will be analyzed for TAL metals. The rationale for selection of sampling locations and analytical parameters is provided in Table 2-5.

There is no justification for analyzing soil samples for pesticides and PCBs because there is no indication that pesticides or PCBs were used at RFS. Therefore, analysis for pesticides and PCBs is not recommended.

TABLE 2-5 RATIONALE FOR PROPOSED SAMPLING - FORMER EXPLOSIVE STORAGE AREAS

SAMPLE NUMBER	SAMPLE DEPTH AND ANALYSIS	RATIONALE FOR SAMPLE LOCATION	RATIONALE FOR ANALYSIS
B1ES-101590	0.5 - 1.5 feet. Analysis: TAL metals	Based on a grid pattern.	General screening for metals under the assumption that they may have been used in this area.
B2ES-101590 This sample will be analyzed only if concentrations of metals are detected above background levels in this area.	Same as above.	Same as above.	Same as above.
B3ES-101590	Same as above.	Same as above.	Same as above.
B4ES-101590 This sample will be analyzed only if concentrations of metals are detected above background levels in this area.	Same as above.	Same as above.	Same as above.

TABLE 2-5 (Continued)

SAMPLE NUMBER	SAMPLE DEPTH AND ANALYSIS	RATIONALE FOR SAMPLE LOCATION	RATIONALE FOR ANALYSIS
B5ES-101590	Same as above.	Same as above.	Same as above.
B6ES-101590 This sample will be analyzed only if concentrations of metals are detected above background levels in this area.	Same as above.	Same as above.	Same as above.
B7ES-101590	Same as above.	Same as above.	Same as above.
B8ES-101590 This sample will be analyzed only if above the background concentrations of metals are detected in this area.	Same as above.	Same as above.	Same as above.
B9ES-101590 B11ES-101590 (duplicate of B8ES- 101590)	Same as above.	Same as above.	Same as above.
B10ES-101590 This sample will be analyzed only if concentrations of metals are detected above background levels in this area.	Same as above.	Same as above.	Same as above.
B11ES-101590	Same as above.	Same as above.	Same as above.

TABLE 2-5 (Continued)

SAMPLE NUMBER	SAMPLE DEPTH AND ANALYSIS	RATIONALE FOR SAMPLE LOCATION	RATIONALE FOR ANALYSIS
B12ES-101590 This sample will be analyzed only if concentrations of metals are detected above background levels in this area.	Same as above.	Same as above.	Same as above.
B13ES-101590	Same as above.	Same as above.	Same as above.
B14ES-101590	Same as above.	Same as above.	Same as above.
B15ES-101590	Same as above.	Same as above.	Same as above.

2.2.2 Former Test Pit Area

2.2.2.1 Description

According to the historical information provided by EPA, two 50-foot deep, steel-lined wells used for explosive testing were located at the southeastern corner of the explosives storage area (see Figure 2-5). These wells were dug up and removed some time in the past. J&A was unable to locate any documents relating to former activity in this area.

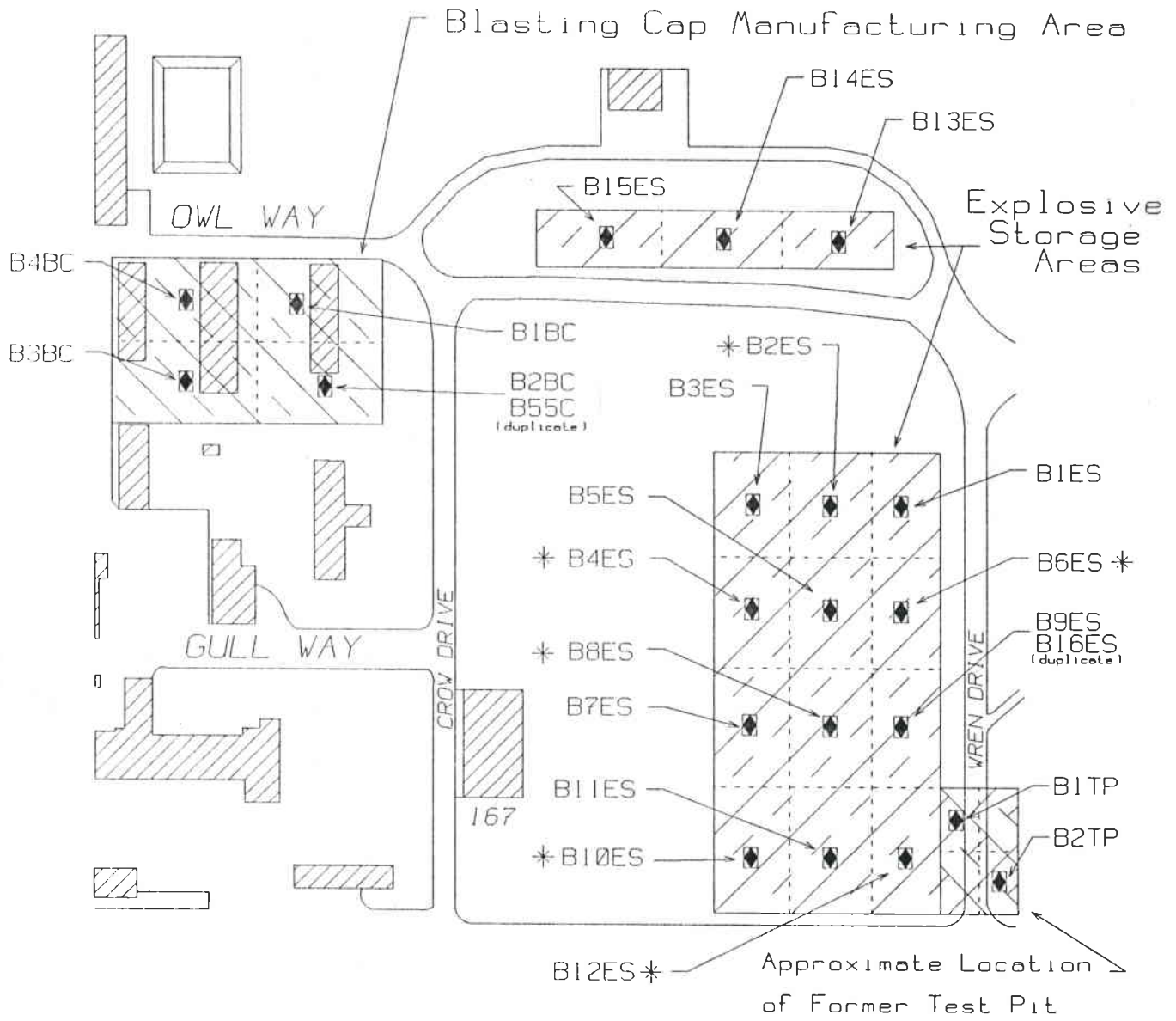
2.2.2.2 Summary of Past Sampling and Analysis

No sampling investigations have been conducted in this area.

2.2.2.3 Potential Contaminants and Additional Data Needs

2.2.2.3.1 Potential Contaminants

Based on the limited information available, it is assumed that metals may be contaminants of concern in this area.

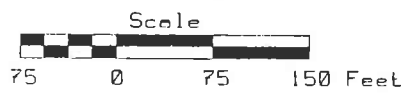


Legend:

Proposed Samples:

◆ Soil

* These samples will be analyzed only if above background concentrations for metals and mercury are detected in this area.



Proposed Sampling Locations - Former Explosive Storage and Blasting Cap Areas and Test Pit

Prepared by
JONAS & ASSOCIATES

Date: 9-30-1990
Scale as shown

Figure 2-5

Drawing Number
90-101-S4425

2.2.2.3.2 Additional Data Needs

The approximate location of the test pit area is approximately 100 by 50 feet. Wren Drive cuts length-wise through the center of the area. In order to screen the area for any potential contaminants, two soil samples (depth range of 0.5 to 1.5 feet) will be collected from this area based on an approximate 50 by 33 foot grid pattern. Samples will be collected from the center of every other square (see Figure 2-5). These samples will be analyzed for TAL metals. Sample numbers, sampling depth, and the rationale for sample locations and analytical parameters are provided in Table 2-6.

TABLE 2-6 RATIONALE FOR PROPOSED SAMPLING - FORMER TEST PIT AREA

SAMPLE NUMBER	SAMPLE DEPTH AND ANALYSIS	RATIONALE FOR SAMPLE LOCATION	RATIONALE FOR ANALYSIS
B1TP-1015907	0.5 - 1.5 feet. Analysis: TAL metals	Based on a 50 by 33 foot grid pattern. Sample collected from the center of every other grid.	General screening for metals under the assumption that they may have been used in this area.
B2TP-101590	Same as above.	Same as above.	Same as above.

2.2.3 Former Blasting Cap Manufacturing Area

2.2.3.1 Description

The former blasting cap manufacturing area is currently occupied by Buildings 160, 163, and 165 (Plate 1-1: Attachment C). The approximate location of the former blasting cap manufacturing area is outlined in Figure 2-5. Detailed information regarding the specific activities performed at the former blasting cap manufacturing area was not available .

2.2.3.2 Summary of Past Sampling and Analysis

In 1982, DHS collected two soil samples in the blasting cap manufacturing area. These samples were analyzed for metals. Mercury was not detected in any of the samples. Metal concentrations for all samples were below TTLC levels.

2.2.3.3 Potential Contaminants and Additional Data Needs

2.2.3.3.1 Potential Contaminants

Metals, specifically mercury, may be present in this areas.

2.2.3.3.2 Additional Data Needs

Four soil samples and one duplicate (0.5 to 1.5 feet) will be collected from the former blasting cap manufacturing area. Soil samples will be analyzed for TAL metals (see Figure 2-5). Sample numbers, sampling depth, and the rationale for selection of sample locations and analytical parameters are provided in Table 2-7.

TABLE 2-7 RATIONALE FOR PROPOSED SAMPLING - FORMER BLASTING CAP MANUFACTURING AREA

SAMPLE NUMBER	SAMPLE DEPTH and ANALYSIS	RATIONALE FOR SAMPLE LOCATION	RATIONALE FOR ANALYSIS
B1BC-101590	0.5 - 1.5 feet. Analysis: TAL metals	Based on an 80 by 50 foot grid pattern.	General screening for metals under the assumption that they may have been used in this area.
B2BC-101590 through B4BC-101590 B5BC-101590 (duplicate of B2BC- 101590)	Same as above.	Same as above.	Same as above.

2.2.4 Vacant Land Northeast of Regatta Boulevard Area

2.2.4.1 Description

This property occupies approximately 9 acres of vacant land located east of Regatta Boulevard and west of the blasting cap manufacturing area. Based on review of a 1946 aerial photograph (Figure 2-3), and Sanborn Fire Insurance Company map (1930 - 1950), it appears that this area has always been vacant.

2.2.4.2 Summary of Past Sampling and Analysis

In 1988, CH2M Hill collected four soil samples from the vacant land northeast of Regatta Boulevard. Samples numbered S5-1 through S5-3 were collected from 0 to 2 feet of surface soil. These samples were composited and analyzed for metals, pesticides, and PCBs. Metals were not detected above TTLC levels. Pesticides and PCBs were not detected above the method detection limits.

A fourth sample, S4-1, was collected 62 feet east of the fence along Regatta Boulevard. This sample was composited with two additional samples numbered S4-2 and S4-3 collected from Area C. The composite sample was analyzed for metals, pesticides, and PCBs. Metals were not detected above TTLC levels. Pesticides and PCBs were not detected above the method detection limits.

2.2.4.3 Potential Contaminants and Additional Data Needs

2.2.4.3.1 Potential Contaminants

Based on a 1946 aerial photograph (Figure 2-3) and Sanborn Fire Insurance Company map (1930 - 1950), it appears that this area has always been vacant. Consequently, there are no sources of soil contamination. In addition, previous sampling has revealed no soil contamination.

2.2.4.3.2 Additional Data Needs

Additional sampling is not proposed because of lack of activities in the area, and the fact that previous studies did not reveal soil contamination.

2.3 AREA C - NORTH-NORTHEAST AREA OF RFS

Area C is the northern part of RFS and is shown on Plate 1-1 (Appendix C). It covers approximately 30 acres and is divided into two sections.

1. Wood Preservation Research Study Area located northeast of Area A.
2. Vacant land and new UC buildings.

A description of each section, summary of past sampling investigations, potential contaminants present, and additional data needs are described below.

2.3.1 Wood Preservation Research Study Area

2.3.1.1 Description

The wood preservation research study area at the Forest Products Laboratory was constructed in the mid-1960s. The first studies conducted at the site involved the treatment of wood with pentachlorophenol in liquified petroleum gas (LPG) mixed with other solvents. These studies continued for five to six years, when the facility was then converted to a waterborne preservative formulation process (see Appendix F). During the conversion, it is believed the LPG with its dissolved pentachlorophenol, was discharged from an aboveground tank to the ground. Pentachlorophenol is likely to be present in the soil in this area (Dost 1989).

Following the conversion, studies at the laboratory involved primarily two wood preservatives: chromated copper arsenate and ammoniacal copper arsenate. There has been some leaking, dripping, and spilling of these chemicals onto the concrete and asphalt adjacent to the treatment cylinder. The practice was to hose the area clean after use. The wash water flowed both toward the southwest of the property (through a drainage swale onto the soil in the adjacent area), and also to the front of the above-ground tank. Eventually waste water flowed through the trench to the rear of the property and discharged into the grassy swell there. In addition, ammoniated water, which was used to rinse freshly treated lumber, also flowed to the trench and then to the grassy swell. Both the soil in the area behind the aboveground tank and the soil in the grassy swell may have been contaminated with limited amounts of chromium, copper, and arsenic (Dost 1989).

2.3.1.2 Summary of Past Sampling and Analysis

On April 28, 1990, J&A collected three composite soil samples from the wood preservation study area. The methodology and findings of this study are included in a J&A report entitled Preliminary Investigation of Potential Soil Contamination at Forest Products Laboratory, Richmond Field Station (1990b). Soil samples (0 - 3 feet) collected from the grassy swale area, the trench (asphalted) area, and the rear of the aboveground tank at the wood preservation study area were analyzed for chromium, copper, arsenic, and pentachlorophenol. Chromium was detected in all three composite samples (BF1: 14 mg/kg; BF2: 14 mg/kg; BF3: 12 mg/kg) at concentrations below the corresponding TTLC levels (chromium VI: 500 mg/kg; chromium III: 2,500 mg/kg). Copper was also detected (BF1: 49 mg/kg; BF2: 120 mg/kg; BF3: 32 mg/kg) at concentrations below the corresponding TTLC level (2,500 mg/kg). Arsenic was not detected in samples BF1 and BF3. The corresponding arsenic concentration in sample BF2 was 16 mg/kg, which is below the TTLC level for arsenic of 500 mg/kg. All three samples were also analyzed for phenols. Phenols were not detected in samples BF1 and BF3. In sample BF2, with the exception of 4-methylphenol (0.340 mg/kg), no other phenols were detected. TTLC levels have not been specified for phenols, except pentachlorophenol (TTLC: 1.7 mg/l).

Metals were detected in low concentrations. In all cases, metals in soils were far below corresponding TTLCs. Phenols were not detected in soils, except for a low concentration of methylphenol in one sample.

2.3.1.3 Potential Contaminants and Additional Data Needs

2.3.1.3.1 Potential Contaminants

Chromium, copper, arsenic, and pentachlorophenol are the primary suspected pollutants. In addition, solvents may also be present

2.3.1.3.2 Additional Data Needs

Based on previous J&A sampling results, no additional soil sampling is recommended (J&A, 1990)

2.3.2 Northwestern Portion of Area C

2.3.2.1 Description

Most of this area consists of vacant land. Building 400, which contains offices, is the only building present in this portion of Area C. Based on a 1946 aerial photograph of the area (Figure 2-3), and a Sanborn Fire Insurance Company map (1930 - 1950), it appears that this area has always been vacant.

2.3.2.2 Summary of Past Sampling and Analysis

In 1982, DHS collected three soil samples from this area (Plate 1-1: Appendix C). These samples were analyzed for metals. Metals were not detected above TTLC levels.

CH2M Hill collected five soil samples, S4-2, S4-3, and S6-1 through S6-3, from this area. One composite sample was prepared from the S6 series and one from S4 series. In preparing the S4 series composite, a sample collected from Area B (S4-1) was also included. These samples were analyzed for metals, pesticides, and PCBs. Metals were not detected above TTLC levels. Pesticides and PCBs were not detected.

2.3.2.3 Potential Contaminants and Additional Data Needs

2.3.2.3.1 Potential Contaminants

Most of this area is a vacant lot. There is no evidence of any activities that may have resulted in a release of hazardous materials in this area. Therefore, no pollutants are expected to be present in this area.

2.3.2.3.2 Additional Data Needs

Both DHS and CH2M Hill's sampling results indicated that metals were not present in area soils above TTLC levels. Furthermore, pesticides and PCBs were not detected during CH2M Hill's study. Because there have been no activities involving hazardous materials in this area, and sampling indicated no contamination, additional sampling is not proposed in this area.

3.0 SAMPLING METHODS AND PROCEDURES

A summary overview of all proposed sampling locations, sample matrices, and analytical parameters is provided in Table 3-1.

TABLE 3-1
SUMMARY OF PROPOSED SAMPLING AND ANALYSIS

SAMPLING AREA	MATRIX	NUMBER OF SAMPLES	ANALYSES	COMMENT
Marsh	Soil (0.5 - 1.5 feet)	11 (10 Plus 1 duplicate)	7 samples: TAL metals; 5 samples: TAL metals, and pesticides.	Soil samples will be collected based on a 200 by 100 foot grid pattern in order to determine whether the marsh has been impacted by activities at the former mercury fulminate and shell manufacturing areas. Four samples will also be analyzed for pesticides to determine if RFS has been impacted by off-site sources.
Marsh	Water	5 (4 plus 1 duplicate)	TAL metals	Currently four surface water pools are located at the marsh. These pools will be sampled and analyzed.
Marsh	Sediment	5 (4 plus 1 duplicate)	TAL metals	Since there are four pools, four sediment samples will also be collected and analyzed.
East Storm Drain	Water Sediment	1 1	TAL metals	
West Storm Drain	Water Sediment	1 1	TAL metals	
Slough	Water (two flood tide, two ebb tide)	4	TAL metals	Four samples (two each) from the southern and the northern ends of the slough.
Slough	Sediment	3	TAL metals	Two sample (one each) at the southern and northern ends of the slough, one half way between these two points.

TABLE 3-1 (Continued)

SAMPLING AREA	MATRIX	NUMBER OF SAMPLES	ANALYSES	COMMENT
Bay	Water	2	TAL metals	One sample collected near the RFS in order to obtain a better understanding of the metal concentrations in the Bay adjacent to RFS. One sample will be collected at a location in the Bay approximately 100 feet from the shoreline to determine metals concentrations fairly distant from RFS.
Bay	Sediment	2	TAL metals	Same as above.
Former Pier	Sediment	1	TAL metals	One lateral composite sample from submerged end of the pier.
Former Pier	Soil (0.5 - 1.5 feet)	1	TAL metals	One lateral composite sample from exposed end of the pier.
Former Test Pit Area	Soil (0.5 - 1.5 feet)	2	TAL metals	Two samples collected based on a 50 by 33 foot grid pattern.

TABLE 3-1 (Continued)

SAMPLING AREA	MATRIX	NUMBER OF SAMPLES	ANALYSES	COMMENT
Hazardous Material Storage Areas Building 118 Building 120 Building 121	Soil (0.5 - 1.0 feet)	1	Total Extractable Hydrocarbons (TEH) and Total Volatile Hydrocarbons (TVH) with BTX&E.	One discrete soil sample per Building will be collected to screen for potential contamination.
	Same as above.	1		
	Same as above.	1		
Former Mercury Fulminate Facility	Soil (0.5 to 1.5 feet)	1	TAL metals & cyanide	One samples will be collected at areas where mercury concentration was 180 and 630 mg/kg. These samples will be analyzed for TAL metals and cyanide. If cyanide and other metals are detected above the background concentrations, then additional samples will also be analyzed for cyanide and TAL metals.
	Soil (0 - 15 feet) collected every 2.5 feet.	6 (5 plus 1 duplicate)	TAL metals	One boring, in the area where 630 mg/kg mercury was detected during the previous sampling, will be extended to a depth of 15 feet. One sample will be collected every 2.5 feet in order to obtain information on the vertical extent of soil contamination.

TABLE 3-1 (Continued)

SAMPLING AREA	MATRIX	NUMBER OF SAMPLES	ANALYSES	COMMENT
Former Shell Manufacturing Area	Soil (0.5 - 1.5 feet)	16 (15 plus 1 duplicate)	TAL metals. Two will be analyzed for cyanide	To complete the existing grid pattern (75 by 60 feet). If cyanide detected above the background level, then additional samples will also be analyzed for cyanide.
Former Shell Manufacturing Area	Soil (0 - 15 feet) collected every 2.5 feet.	6 (5 plus 1 duplicate)	TAL metals	Vertical profiling will be performed at location where highest mercury concentration was detected thus far. Based on the result of this profile, depth for future vertical profiling will be determined.
Former Explosive Storage Area	Soil (0.5 - 1.5 feet)	16 (15 plus 1 duplicate)	TAL metals	Based on a grid pattern (80 by 50 feet), 15 soil samples (plus a duplicate) will be collected. Twelve of these samples will be collected from the larger explosive storage area. Initially six (plus one duplicate) of these samples will be analyzed. If high levels (above background) of metals are detected, then the other six will also be analyzed for the same suite of parameters. Otherwise, six samples in this area will be considered representative and adequate.
Former Blasting Cap Manufacturing Area	Soil (0.5 - 1.5 feet)	5 (4 plus 1 duplicate)	TAL metals	Based on a grid pattern (80 by 75 feet), four (plus a duplicate) soil samples will be collected and analyzed.

3.1 SOIL SAMPLE COLLECTION PROCEDURES

3.1.1 Surface Soil Sample Collection Procedures

During the onsite field effort, soil samples will be obtained using a two-inch stainless steel hand auger. Exact soil sample location will be based not only on the aforementioned grid patterns but also on the visual inspection of the area to be sampled. Areas where soil discoloration is observed will be preferentially sampled. If fill material is encountered, the sample will be collected below the fill material. During the soil sample collection at the marsh area, if the anticipated sample location is covered with surface water, the sample location will be moved approximately two feet away from the water.

Surface soil samples from 0.5 - 1.5 feet deep will be obtained using a hand auger. The soil will be placed into a labeled, airtight glass container. A sufficient amount of soil will be collected for the selected laboratory analyses. The minimum sample volume required for laboratory analysis is 270 grams. Sample containers from each borehole will be sealed in individual plastic bags. Samples will then be placed into an insulated cooler for shipment to the laboratory, maintaining the temperature at approximately 4° Celsius. Soil sampling equipment will be decontaminated according to the procedures described in Section 3.4 of the SAP.

Table 3-2 identifies each sampling point, proposed analysis, container type, sample volume, preservative, and analytical holding times for each parameter, as well as sampling date.

3.1.2 Vertical Profiling Soil Sample Collection Procedures

Soil samples will be collected with a split-barrel drive sampler using a hollow-stem drilling method. Hollow-stem auger drilling is accomplished utilizing a hollow central shaft to which is attached a spiral scroll. Each section of auger is aligned so that a continuous scroll is formed. A bit is attached at the bottom of the first auger flight. Cuttings created by the bit are removed by the scroll as the auger stem is turned. This method is suitable for relatively shallow drilling in unconsolidated formations. Soil borings will be drilled with an auger rig utilizing eight-inch outside diameter (OD) hollow-stem augers. Two borings for soil sampling will be drilled to a maximum depth of 15 feet. As stated above, the soil samples will be collected with a split-barrel sampler with three brass liner tubes. The brass liners and sampler will be steam-cleaned before use. After the sampler is withdrawn from the borehole, it will be opened and its brass sleeves set out. If the middle brass sleeve is full, it will be submitted for analysis; otherwise, the bottom sleeve will be submitted. The ends of brass sleeves to be submitted for analysis

TABLE 3-2 Sampling Date, Location, Proposed Analyses, Container Type, Preservative, and Analytical Holding Time

CHEMISTRY TYPE	INORGANIC	INORGANIC	INORGANIC	INORGANIC	ORGANIC	ORGANIC
Analyses Requested	MERCURY (Low)	TAL METALS (Low)	CYANIDE (Low)	PESTICIDES (Low)	TEH/TVH/BTX&E (Low)	
PRESERVATIVES	Chill to 4 C	Chill to 4 C	Chill to 4 C	Chill to 4 C	Chill to 4 C	Chill to 4 C
	pH<2 with HNO3	pH<2 with HNO3				
ANALYTICAL HOLDING TIME	Hold to <26 days	Hold to <180 day	Hold to <14 days	Hold to 14 day	Hold to <14 days	
Sample Number	Sample Location	Matrix	Schedule	Soil: 1 x 4-OZ	Soil: 1 x 4-OZ	Soil: 1 x 4-OZ
				Wide-Mouth	Wide-Mouth	Wide-Mouth
				Glass jars	Glass jars	Glass jars
				Water: 1 x 1-LT	Water: 1 x 1-LT	
				Polyeth. bottle	Polyeth. bottle	
B1SH-101590	SHELL MANUFAC.	SOIL	10/15/90	1	1	1
B2SH-101590	SHELL MANUFAC.	SOIL	10/15/90	1	1	1
B3SH-101590	SHELL MANUFAC.	SOIL	10/15/90	1	1	1
B4SH-101590	SHELL MANUFAC.	SOIL	10/15/90	1	1	1
B5SH-101590	SHELL MANUFAC.	SOIL	10/15/90	1	1	1
B6SH-101590	SHELL MANUFAC.	SOIL	10/15/90	1	1	1
B7SH-101590	SHELL MANUFAC.	SOIL	10/15/90	1	1	1
B8SH-101590	SHELL MANUFAC.	SOIL	10/15/90	1	1	1
B9SH-101590	SHELL MANUFAC.	SOIL	10/15/90	1	1	1
B10SH-101590	SHELL MANUFAC.	SOIL	10/15/90	1	1	1
B11SH-101590	SHELL MANUFAC.	SOIL	10/15/90	1	1	1
B12SH-101590	SHELL MANUFAC.	SOIL	10/15/90	1	1	1
B13SH-101590	SHELL MANUFAC.	SOIL	10/15/90	1	1	1
B14SH-101590	SHELL MANUFAC.	SOIL	10/15/90	1	1	1
B15SH-1.5-101590	SHELL MANUFAC.	SOIL	10/15/90	1	1	1
B15SH-4-101590	SHELL MANUFAC.	SOIL	10/15/90	1	1	1
B15SH-6.5-101590	SHELL MANUFAC.	SOIL	10/15/90	1	1	1
B15SH-9-101590	SHELL MANUFAC.	SOIL	10/15/90	1	1	1
B15SH-11.5-101590	SHELL MANUFAC.	SOIL	10/15/90	1	1	1
B15SH-14-101590	SHELL MANUFAC.	SOIL	10/15/90	1	1	1
B16SH-101590	SHELL MANUFAC.	SOIL	10/15/90	1	1	1

TABLE 3-2 (Continued)

CHEMISTRY TYPE	INORGANIC	INORGANIC	INORGANIC	INORGANIC	INORGANIC	ORGANIC	ORGANIC
Analyses Requested	MERCURY (low)	TAL METALS (low)	CYANIDE (low)	PESTICIDES (low)	TEH/TVH/BTX&E (low)		
PRESERVATIVES	Chill to 4 C pH<2 with HNO3	Chill to 4 C pH<2 with HNO3	Chill to 4 C	Chill to 4 C	Chill to 4 C	Chill to 4 C	Chill to 4 C
SOIL, SEDIMENT, AND WATER WATER	Hold to <26 days	Hold to <180 day	Hold to <14 days	Hold to 14 day	Hold to <14 days	Hold to <7 day	Hold to <14 days
ANALYTICAL HOLDING TIME							
Sample Number	Matrix	Schedule	Soil: 1 x 4-OZ	Wide-Mouth	Glass jars	Water: 1 x 1-LT	Polyeth. bottle
Sample Location	SOIL	10/15/90	1	1	1	1	1
SHELL MANUFAC.							
(DUP. OF B15SH-1.5-101590)							
B18SH-101590	SOIL	10/15/90	1	1	1	1	1
(DUP. OF B14SH-101590)							
B1MF-101590	SOIL	10/15/90	1	1	1	1	1
B2MF-1.5-101590	SOIL	10/15/90	1	1	1	1	1
B2MF-4-101590	SOIL	10/15/90	1	1	1	1	1
B2MF-6.5-101590	SOIL	10/15/90	1	1	1	1	1
B2MF-9-101590	SOIL	10/15/90	1	1	1	1	1
B2MF-11.5-101590	SOIL	10/15/90	1	1	1	1	1
B2MF-14-101590	SOIL	10/15/90	1	1	1	1	1
B3MF-101590	SOIL	10/15/90	1	1	1	1	1
(DUP. OF B2MF-1.5-101590)							
B1MA-101590	SOIL	10/15/90	1	1	1	1	1
B2MA-101590	SOIL	10/15/90	1	1	1	1	1
B3MA-101590	SOIL	10/15/90	1	1	1	1	1
B4MA-101590	SOIL	10/15/90	1	1	1	1	1
B5MA-101590	SOIL	10/15/90	1	1	1	1	1

TABLE 3-2 (Continued)

CHEMISTRY TYPE	INORGANIC	INORGANIC	INORGANIC	INORGANIC	INORGANIC	ORGANIC	ORGANIC
Analyses Requested							
	MERCURY (low)	TAL METALS (low)	CYANIDE (low)	PESTICIDES (low)	TEH/TVH/BTX&E (low)		
PRESERVATIVES							
SOIL, SEDIMENT, AND WATER	Chill to 4 C	Chill to 4 C	Chill to 4 C	Chill to 4 C	Chill to 4 C	Chill to 4 C	Chill to 4 C
WATER	pH<2 with HNO3	pH<2 with HNO3					
ANALYTICAL HOLDING TIME	Hold to <26 days	Hold to <180 day	Hold to <14 days	Hold to 14 day	Hold to <14 days	Hold to <7 day	Hold to <14 days
SOIL AND SEDIMENT							
WATER							
Sample Number	Matrix	Schedule	Soil: 1 x 4-OZ	Wide-Mouth	Glass jars	Water: 1 x 1-LT	Polyeth. bottle
B6MA-101590	SOIL	10/15/90	1	1			
B7MA-101590	SOIL	10/15/90	1	1			
B8MA-101590	SOIL	10/15/90	1	1			
B9MA-101590	SOIL	10/15/90	1	1			
B10MA-101590	SOIL	10/15/90	1	1			
B11MA-101590	SOIL	10/15/90	1	1			
(DUP. OF B10MA-101590)							
B1B118-101590	SOIL	10/15/90					
B1B120-101590	SOIL	10/15/90					
B1B121-101590	SOIL	10/15/90					
B1ES-101590	EXPLOSIVES STORAGE	10/15/90	1	1			
B2ES-101590*	EXPLOSIVES STORAGE	10/15/90	1	1			
B3ES-101590	EXPLOSIVES STORAGE	10/15/90	1	1			
B4ES-101590*	EXPLOSIVES STORAGE	10/15/90	1	1			
B5ES-101590	EXPLOSIVES STORAGE	10/15/90	1	1			
B6ES-101590*	EXPLOSIVES STORAGE	10/15/90	1	1			
B7ES-101590	EXPLOSIVES STORAGE	10/15/90	1	1			

TABLE 3-2 (Continued)

[illegible]

TABLE 3-2 (Continued)

CHEMISTRY TYPE	INORGANIC	INORGANIC	INORGANIC	INORGANIC	ORGANIC	ORGANIC
Analyses Requested	MERCURY (LOW)	TAL METALS (LOW)	CYANIDE (LOW)	PESTICIDES (LOW)	TEH/TVH/BTX&E (LOW)	
PRESERVATIVES	Chill to 4 C pH<2 with HNO3	Chill to 4 C pH<2 with HNO3	Chill to 4 C	Chill to 4 C	Chill to 4 C	Chill to 4 C
SOIL, SEDIMENT, AND WATER WATER						
ANALYTICAL HOLDING TIME	Hold to <26 days	Hold to <180 day	Hold to <14 days	Hold to 14 day	Hold to <14 days	
SOIL AND SEDIMENT WATER						
Sample Number	Matrix	Schedule	Soil: 1 x 4-OZ	Soil: 1 x 4-OZ	Soil: 1 x 4-OZ	BRASS SLEEVE
B1PR-101590	PIER	10/15/90	1	1	1	
B1BG-101590	Background NW OF AREA C	10/15/90	1	1	1	
B1BG-101590	Background NW OF AREA C	10/15/90	1	1	1	
SD1MA-101590	MARSH	10/15/90	1	1	1	
SD2MA-101590	MARSH	10/15/90	1	1	1	
SD3MA-101590	MARSH	10/15/90	1	1	1	
SD4MA-101590	MARSH	10/15/90	1	1	1	
SD5MA-101590	MARSH	10/15/90	1	1	1	
(DUP. OF SD4MA-101590)						
SD1WSD-101590	WEST STORM DRAIN	10/15/90	1	1	1	
SD1ESD-101590	EAST STORM DRAIN	10/15/90	1	1	1	

TABLE 3-2 (Continued)

CHEMISTRY TYPE	INORGANIC	INORGANIC	INORGANIC	INORGANIC	INORGANIC	ORGANIC	ORGANIC
Analyses Requested	MERCURY (low)	TAL METALS (low)	CYANIDE (low)	PESTICIDES (low)	TEH/TVH/BTX&E (low)		
PRESERVATIVES	Chill to 4 C pH<2 with HNO3	Chill to 4 C pH<2 with HNO3	Chill to 4 C	Chill to 4 C	Chill to 4 C	Chill to 4 C	
SOIL, SEDIMENT, AND WATER WATER	Hold to <26 days	Hold to <180 day	Hold to <14 days	Hold to 14 day	Hold to <14 days	Hold to <14 days	
ANALYTICAL HOLDING TIME							
Sample Number	Sample Location	Matrix	Schedule	Soil: 1 x 4-OZ Wide-Mouth Glass jars	Soil: 1 x 4-OZ Wide-Mouth Glass jars	Soil: 1 x 4-OZ Wide-Mouth Glass jars	BRASS SLEEVE
SD1SL-101590	SLOUGH	SEDIMENT	10/15/90	1	1	1	
SD2SL-101590	SLOUGH	SEDIMENT	10/15/90	1	1	1	
SD3SL-101590	SLOUGH	SEDIMENT	10/15/90	1	1	1	
SD1BAY-101590	BAY	SEDIMENT	10/15/90	1	1	1	
SD2BAY-101590	BAY	SEDIMENT	10/15/90	1	1	1	
SD1PR-101590	PIER	SEDIMENT	10/15/90	1	1	1	
SW1MA-101590	MARSH	WATER	10/15/90	1	1	1	
SW2MA-101590	MARSH	WATER	10/15/90	1	1	1	
SW3MA-101590	MARSH	WATER	10/15/90	1	1	1	
SW4MA-101590	MARSH	WATER	10/15/90	1	1	1	
SW5MA-101590	MARSH	WATER	10/15/90	1	1	1	
(DUP. OF SW4MA-101590)							
SW1WSDR-101590	WEST STORM	WATER	10/15/90	1	1	1	
SW1ESDR-101590	EAST STORM	WATER	10/15/90	1	1	1	

TABLE 3-2 (Continued)

CHEMISTRY TYPE	INORGANIC	INORGANIC	INORGANIC	INORGANIC	INORGANIC	ORGANIC	ORGANIC
Analyses Requested	MERCURY (LOW)	TAL METALS (LOW)	CYANIDE (LOW)	PESTICIDES (LOW)	TEH/TVH/BTX&E (LOW)		
PRESERVATIVES	Chill to 4 C pH<2 with HNO3	Chill to 4 C pH<2 with HNO3	Chill to 4 C	Chill to 4 C	Chill to 4 C	Chill to 4 C	
SOIL, SEDIMENT, AND WATER WATER							
ANALYTICAL HOLDING TIME	Hold to <26 days	Hold to <180 day	Hold to <14 days	Hold to 14 day	Hold to <14 days	Hold to <7 day	Hold to <14 days
WATER							
Sample Number	Matrix	Schedule	Soil: 1 x 4-OZ Wide-Mouth Glass jars Water: 1 x 1-LT Polyeth. bottle	Soil: 1 x 4-OZ Wide-Mouth Glass jars Water: 1 x 1-LT Polyeth. bottle	Soil: 1 x 4-OZ Wide-Mouth Glass jars Water: 1 x 1-LT Polyeth. bottle	Soil: 1 x 4-OZ Wide-Mouth Glass jars	BRASS SLEEVE
SW1SLEB-DATE	WATER	TBD	1	1			
SW1SLFL-DATE	WATER	TBD	1	1			
SW2SLEB-DATE	WATER	TBD	1	1			
SW2SLFL-DATE	WATER	TBD	1	1			
SW1BAY-101590	WATER	TBD	1	1			
SW2BAY-101590	WATER	TBD	1	1			
SW1FB-101590	WATER	TBD	1	1			
FIELD BLANK							

TABLE 3-2 (Continued)

	CHEMISTRY TYPE	INORGANIC	INORGANIC	TAL METALS (Low)	CYANIDE (Low)	PESTICIDES (Low)	TEH/TVM/BTX&E (Low)
	Analyses Requested	MERCURY (Low)					
	PRESERVATIVES	Chill to 4 C pH<2 with HNO ₃	Chill to 4 C pH<2 with HNO ₃	Chill to 4 C	Chill to 4 C	Chill	Chill
	SOIL, SEDIMENT, AND WATER						
	WATER						
	ANALYTICAL HOLDING TIME	Hold to <26 days	Hold to <180 day	Hold to <14 days	Hold to 14 day	Hold to <7 day	Hold to <14 days
	WATER						
	SAMPLE NUMBER	Sample Location	Matrix	Schedule	Soil: 1 x 4-OZ Wide-Mouth Glass jars Water: 3 x 1-LT Polyeth. bottle	Soil: 1 x 4-OZ Wide-Mouth Glass jars Water: 1 x 1-LT Polyeth. bottle	BRASS SLEEVE
	LQC1-DATE	LABORATORY QA/QC SAMPLE	WATER	TBD	1	1	
	LQC1-DATE	LABORATORY QA/QC SAMPLE	WATER	TBD	1	1	
	LQC1-DATE	LABORATORY QA/QC SAMPLE	WATER	TBD	1	1	
	LQC1-DATE	LABORATORY QA/QC SAMPLE	WATER	TBD	1	1	

* This sample will be analyzed only if concentrations of metals and mercury are detected above background levels in this area.

TBD = To be determined.

Note: sampling date may change. Therefore, the last part of sample number representing the date will also change.

will be covered with Teflon film and tight-fitting plastic caps that will be secured with duct tape. A normal 6-inch by 2-inch soil sample will contain approximately 18.85 cubic inches of soil. Assuming a density of 2 grams/cubic centimeter (32.78 grams/cubic inch), this should provide over 600 grams of material. The minimum sample volume required for laboratory analysis is 270 grams. Therefore, a full brass sleeve should provide sufficient soil for all analyses to be performed. All samples will be labeled and accompanied by a Chain-of-Custody record. After labeling, the sample will be stored in an ice chest at 4°C until it can be transferred to the laboratory by J&A field crew. All soil samples will be logged in general accordance with "Description of Soils (Visual Manual Procedures)", ASTM D2488-69, which is based on the Unified Soil Classification System.

After completion of sample collection, the hole will be backfilled with a slurry of five percent bentonite, cement, and sand. The surface will be restored to its original condition. The cuttings will be collected in drums or boxes and set aside for appropriate disposal. Waste handling is discussed in Section 3.5. Soil sampling equipment will be decontaminated according to the procedures described in Section 3.4 of the SAP.

3.2 SURFACE WATER SAMPLE COLLECTION PROCEDURES

Surface water sampling will take place within San Francisco Bay, the nearby slough, four surface water pools in the marsh, and the east and west drainage onsite. Surface water will be collected in a stainless steel or Teflon bailer which will be immersed below the water surface. The water will be carefully poured into one liter plastic bottles provided by Curtis & Tompkins, Ltd. Analytical Laboratory (C&T). Samples for TAL metals will be poured directly from the bailer into the sample container. The pH of the metals will be adjusted with nitric acid (HNO₃) to a pH of less than two within 24 hours of collection.

All samples will be labeled and accompanying Chain-of-Custody record will be filled out, following procedures detailed in Sections 3.6 through 3.10 of the SAP. After labeling, the samples will be kept refrigerated at 4°C in an ice chest until they can be transferred to the laboratory by J&A field crew.

Soil sampling equipment will be decontaminated according to the procedures described in Section 3.4 of the SAP.

3.3 SEDIMENT SAMPLE COLLECTION PROCEDURES

Sediment samples will be collected from the San Francisco Bay, the slough that travels through RFS property, four pools located in the marsh, and the two (east and west) surface drainage onsite.

will be covered with Teflon film and tight-fitting plastic caps that will be secured with duct tape. A normal 6-inch by 2-inch soil sample will contain approximately 18.85 cubic inches of soil. Assuming a density of 2 grams/cubic centimeter (32.78 grams/cubic inch), this should provide over 600 grams of material. The minimum sample volume required for laboratory analysis is 270 grams. Therefore, a full brass sleeve should provide sufficient soil for all analyses to be performed. All samples will be labeled and accompanied by a Chain-of-Custody record. After labeling, the sample will be stored in an ice chest at 4°C until it can be transferred to the laboratory by J&A field crew. All soil samples will be logged in general accordance with "Description of Soils (Visual Manual Procedures)", ASTM D2488-69, which is based on the Unified Soil Classification System.

After completion of sample collection, the hole will be backfilled with a slurry of five percent bentonite, cement, and sand. The surface will be restored to its original condition. The cuttings will be collected in drums or boxes and set aside for appropriate disposal. Waste handling is discussed in Section 3.5. Soil sampling equipment will be decontaminated according to the procedures described in Section 3.4 of the SAP.

3.2 SURFACE WATER SAMPLE COLLECTION PROCEDURES

Surface water sampling will take place within San Francisco Bay, the nearby slough, four surface water pools in the marsh, and the east and west drainage onsite. Surface water will be collected in a stainless steel or Teflon bailer which will be immersed below the water surface. The water will be carefully poured into one liter plastic bottles provided by Curtis & Tompkins, Ltd. Analytical Laboratory (C&T). Samples for TAL metals will be poured directly from the bailer into the sample container. The pH of the metals will be adjusted with nitric acid (HNO₃) to a pH of less than two within 24 hours of collection.

All samples will be labeled and accompanying Chain-of-Custody record will be filled out, following procedures detailed in Sections 3.6 through 3.10 of the SAP. After labeling, the samples will be kept refrigerated at 4°C in an ice chest until they can be transferred to the laboratory by J&A field crew.

Soil sampling equipment will be decontaminated according to the procedures described in Section 3.4 of the SAP.

3.3 SEDIMENT SAMPLE COLLECTION PROCEDURES

Sediment samples will be collected from the San Francisco Bay, the slough that travels through RFS property, four pools located in the marsh, and the two (east and west) surface drainage onsite.

Sediment samples will be collected using a stainless steel hand auger. The sediment samples will be obtained as grab samples at a depth of about six inches from the pools. The sample equipment will be decontaminated between sampling events. Sediment samples will be placed in glass, wide mouth jars provided by C&T. All samples will be labeled and accompanying Chain-of-Custody records will be filled out, following procedures detailed in Sections 3-6 through 3-10 of the SAP. After labeling, the samples will be kept refrigerated at 4°C in an ice chest until they can be transferred to the laboratory by J&A field crew.

Sediment samples from the Bay, approximately 300 feet from the shoreline will be collected from a boat/raft. A hand auger with a long extension handle will be used.

Soil sampling equipment will be decontaminated according to the procedures described in Section 3.4 of the SAP.

3.4 DECONTAMINATION AND POST-SAMPLING PROCEDURES

Decontamination of equipment will occur at a specific zone designated at the site. Sampling equipment will be decontaminated prior to initial use, between sample locations, and at the completion of sampling activities. Items requiring decontamination include the stainless steel hand auger, teflon bailer, stainless steel spoon and a scooper, and brass tubes. A manual scrubbing to remove foreign material followed by a thorough cleaning will be done for decontamination of the above items. All nondisposable equipment will be decontaminated according to the procedures summarized below:

- o Manual scrub with non-phosphate soap solution followed by a tap water wash
- o Tap water rinse
- o Distilled/deionized water rinse
- o 0.1N nitric acid rinse
- o Distilled/deionized water rinse
- o Air dry
- o Distilled/deionized water rinse

3.5 WASTE HANDLING PROCEDURES

Wastes produced during field operations include solids, liquids, and a combination of the two.

Combinations will be separated into liquid and solid fractions. The solid and the liquid fraction will be kept in separate 55-gallon drums approved by the Department of Transportation (DOT). Each drum will be labeled with the following information.

- o Source of waste.
- o Date drummed.

- Type of waste.
- Specific identification of waste (i.e., decontamination water).
- Initials of person marking the drum.

The work site will be left clean and free of debris. Trash will be discarded in rubbish bins. The containers will be moved to a fenced storage area. The waste will be kept at the fenced area until the analytical results for the samples collected has been received from the laboratory. Based on the analytical results, the waste will be characterized as hazardous or nonhazardous. Hazardous wastes will be manifested and transported offsite by a licensed hauler to a licensed treatment/storage/disposal facility.

Materials that become contaminated during sampling or other field activities that cannot be decontaminated and reused, will be drummed for disposal. These materials include Tyvek suits, gloves, and respirator filters, as well as disposable sampling equipment.

3.6 SAMPLE DOCUMENTATION

Sample documentation includes field logbooks, sample labels, and Chain-of-Custody records. All field documentation will be written legibly in waterproof ink. Errors will be crossed out with a single line, initialed, and dated.

3.7 SAMPLE IDENTIFICATION NUMBERS

Each surface soil sample will be assigned a unique identification number that will allow retrieval of information regarding the sample. The sample identification number consists of three main parts, separated by a hyphen. The first part identifies the boring number, and is made up of the letter "B" for "boring", and a one or two digit number representing the boring number. The second part represents the abbreviation for the area sampled. The third part, is the sampling date.

Example: B1-SH-101590

Represents: Boring # 1, taken at the shell manufacturing area on October 15, 1990.

For vertical profiling, an additional number, representing sample depth will be added to the sampling number.

Example: B14-SH-2.5-101590

Represents: Boring # 14, collected from the shell manufacturing area at a depth of 2.5 feet on October 15, 1990.

Surface water sample identification numbers will consist of three parts. The first part identifies the sample number, and is made up of the letters "SW" for "surface water" and a one to two digit number representing the sample number. The second part

represents the area sampled i.e., "Bay" for Bay, "SL" for slough or "MAR" for marsh. The third part, is the sampling date.

Example: SW1-Bay-DATE
Represents: Surface water sample # 1 collected from the Bay on specified date.

Sediment samples will be identified in the same manner as surface water samples.

Example: SD1-Bay-101590
Represents: Sediment sample # 1 collected from the Bay on October 15, 1990.

Duplicate, background and equipment blank samples will be numbered in the same manner as the corresponding matrix samples.

3.8 FIELD LOGBOOKS

A project field logbook will be used to document the following information.

- o Date and time of log entries.
- o Field conditions (weather, terrain, hazards, etc.).
- o Personnel present during field operations.
- o Decontamination procedures.
- o Waste disposal procedures, and a daily inventory of wastes present onsite.
- o Field measurements taken, instrumentation used, and frequency of instrument calibration.
- o Maintenance of instruments.
- o Information recorded on sample labels, as well as the site identification number and the sampling depth.
- o Any unusual sample characterization.
- o Other specific considerations pertaining to sample acquisition.

3.9 SAMPLE LABELS

A preprinted adhesive label will be affixed to each sample container (Figure 3-1). The information below will be written on every sample label.

- o Project number.
- o Sample identification number.
- o Date of sampling.
- o Name of sample collector.
- o Type of analysis requested.

Figure 3-1
Sample Label

Curtis & Tompkins, Ltd., 2323 Fifth Street Berkeley, California 94710	
SAMPLE NO.	DATE
CUSTOMER	
SIGNATURE	
TYPE OF ANALYSIS	

3.10 CHAIN-OF-CUSTODY RECORDS

A Chain-of-Custody record will accompany samples when they are shipped to the laboratory (Figure 3-2). The Chain-of-Custody record documents the transfer of samples from one party to another. Additional information noted on this form includes the following.

- o Project number.
- o Sample identification number.

[illegible]

- o Date and time of sampling.
- o Type of sample.
- o Type of analysis to be performed.

3.11 QUALITY CONTROL SAMPLES

Duplicate soil samples will be collected with a frequency of ten percent for each sample type and analytical parameter. It is anticipated that six duplicate soil, one duplicate sediment, and one duplicate surface water samples will be collected. Proposed locations for collection of the duplicate soil samples are presented in Figures 2-1, 2-2, and 2-5. The duplication of samples is a means of checking field and laboratory procedures. Duplicates are collected, numbered, and sealed in the same manner as other samples. Field duplicates are collected from sampling points that are known or suspected to be contaminated, and are analyzed for the same parameters as all related samples. Analysis of field duplicates assists in assessing the precision of field and laboratory techniques. Since soil samples collected in an acceptable manner can have results which differ significantly, the use of soil duplicates to determine precision of sampling and analytical techniques, must take into account the fact of natural variability of concentrations in soil.

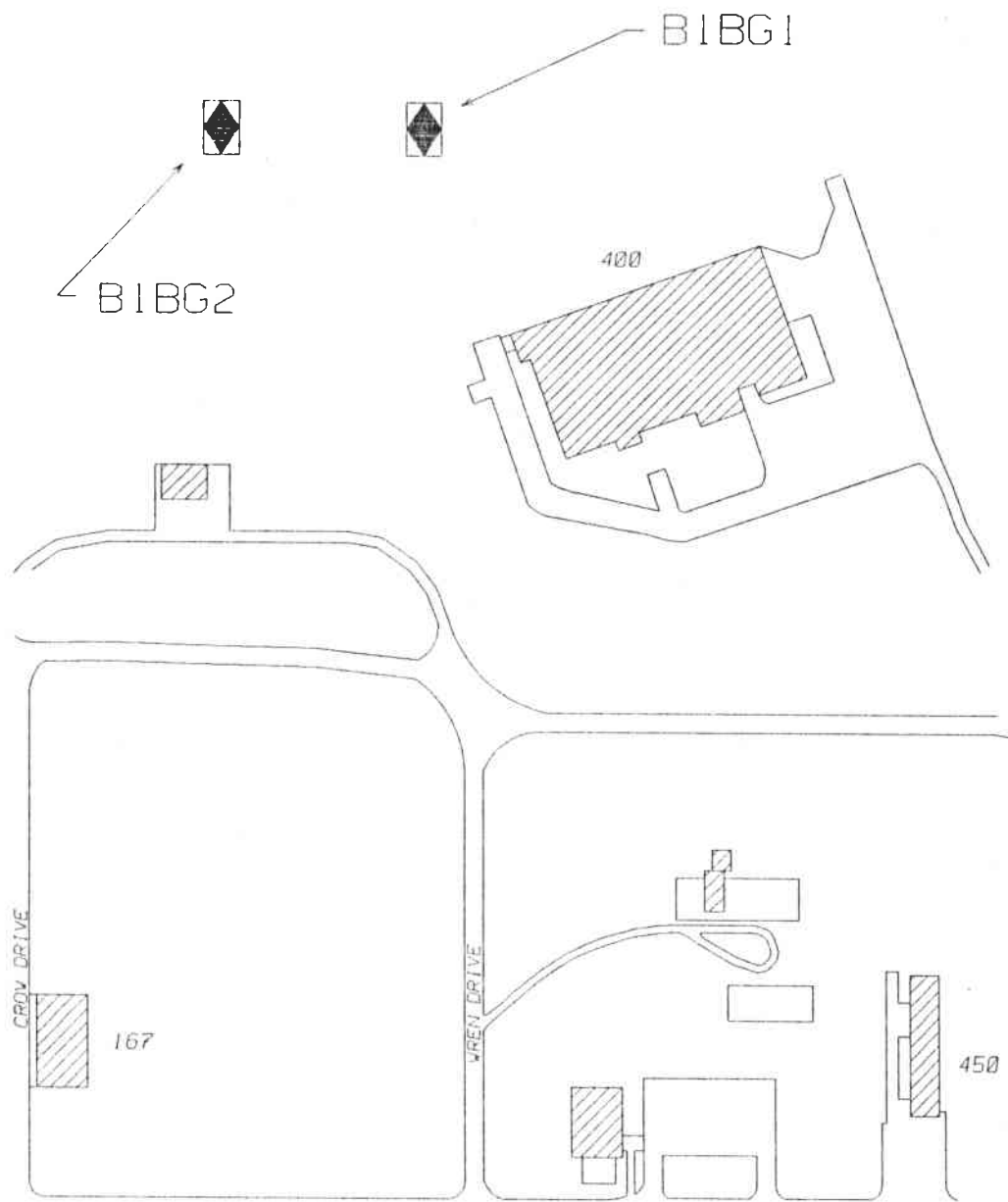
One field sample per week or 1 per 20 samples (including field blanks and duplicates), whichever is greater, will be designated as the lab quality control (QC) sample for the matrix spike and duplicate analyses. For water matrices, 2-3 times the normal sample volume will be collected for the laboratory QC sample. It is anticipated that one laboratory QC sample for water will be collected and analyzed for TAL metals, and cyanide.

One equipment blank will be collected during the surface water sampling. It is anticipated that all surface water sampling will be performed in one day. This sample will be analyzed for TAL metals. Surface water samples will be collected with a teflon bailer. After decontamination, the bailer will be rinsed with distilled water. The final distilled water rinse will be collected in a sample container and submitted to the laboratory for analysis of TAL metals.

3.12 BACKGROUND SAMPLES

3.12.1 Background Soil Samples

Two background soil samples (0.5 - 1.5 feet depth range) will be collected and analyzed for TAL metals, and cyanide. The area where background soils will be collected is located northwest of Area C, east of Starling Way, approximately 120 feet west/northwest of Building 400 (see Figure 3-3). The samples will be collected approximately 125 feet



Legend:

Proposed Samples:

◆ Soil/Background

Proposed Locations
for Background Samples

Prepared by

JONAS & ASSOCIATES

Scale
100 0 100 200 Feet

Date: 9-30-1990
Scale as shown

Figure 3-3

Drawing Number
90-101-S4426

apart. The general sample locations were selected based on the available information regarding the historical and current activities at RFS. Currently, no activities which may adversely impact this area are being conducted at this part of the RFS. The available historical records indicate that the area was always vacant.

3.12.2 Background Surface Water and Sediment Samples

Background sediment and surface water samples will not be collected. However, a literature search will be performed to determine if background concentrations for chemicals of concern have been established for San Francisco Bay.

3.13 SAMPLE SHIPMENT

The J&A Technical Manager will notify the Sales Manager at C&T a week before each round of sampling will be scheduled to begin, so that the laboratory can prepare and ship the necessary coolers and sample bottles to the field team in advance. Each shipment of sampling supplies from C&T will be accompanied by a cooler packing slip, which will document the number of coolers and the number and type of sample containers sent.

Samples will be packaged for shipment in a cooler chilled with bags of ice. Sample jars will be placed in sealed Zip-lock bags. When possession of the samples is transferred, the individuals relinquishing and accepting custody will write their names, the names of their organizations, and the time of custody transfer on the Chain-of-Custody record(s).

3.13.1 Preparation for Laboratory Analysis

Soil, sediment, and water samples will be collected for laboratory analyses. The parameters to be analyzed, required sample containers, and preservation and holding times are presented in Table 3-2. Individual parameters and their detection limits are presented in Section 5.0 of the SAP.

3.13.2 Sample Containers

C&T will provide the field team with clean sample containers and preservatives. Brass sleeves and other sampling equipment will be decontaminated by J&A prior to usage. A description of the containers to be used when collecting samples for each analytical method is presented in Table 3-2.

3.13.3 Sample Preservation and Holding Times

All samples will be stored in an ice-filled cooler chilled to 4°C until they can be delivered by J&A field crew to the laboratory for analysis. If the samples are retained onsite overnight, they will be kept in a secured area. The samples will either be kept in coolers or placed in a refrigerator, depending on space availability.

Water and soil samples designated for metals analysis will be analyzed within 28 days of collection. The water samples will be adjusted in the field to a pH less than 2 using 3 ml of 1:1 nitric acid (HNO_3) per liter of sample.

Surface water samples to be analyzed for total cyanide analysis will be adjusted in the field to a pH greater than 12 using 2 ml 10 N sodium hydroxide (NaOH) per liter of sample. The holding time for cyanide samples will not exceed 14 days. Preservation method, minimum sample sizes, and holding times for samples are summarized in Table 3-2.

4.0 DATA QUALITY ASSESSMENT

The quality of all data generated and processed during this investigation will be assessed for precision, accuracy, representativeness, comparability, and completeness based upon the available external measures of quality. C&T laboratory will follow the Routine Analytical Services (RAS) for the TAL metals. The multimedia RAS Statement of Work (SOW) will be followed for all inorganic analysis. For organics, SOW 788 will be followed. The format in which the data will be generated by the laboratory will not be in the same as may be required by the Contract Laboratory Program (CLP) requirements. However, all the required information will be provided in a compatible format.

One of the techniques used to assess laboratory data quality is data validation. Validation of data requires that appropriate QA/QC and documentation steps be performed in both the laboratory and the field. Professionals trained in data validation procedures review this information, "flag" data when QA/QC criteria are not met, and prepare the data validation report.

Validation of analytical data will be performed on 10 percent of the data collected by J&A. Data to be validated will be selected in the following manner:

Sixty seven soil samples, 11 surface water, and 11 submerged sediment samples (including duplicates and the background samples) will be collected. This brings the total of samples to 89. Ten percent of 89 is approximately eight. Therefore, eight samples will be selected for data validation.

Of the total 89 samples, approximately 75 percent are soil, 12 percent are surface water, and 12 percent are submerged sediment samples. Seventy five percent of eight samples is six; 12 percent of the eight samples is approximately one. Therefore, six soil, one surface water, and one submerged sediment sample will be selected for data validation.

Surface and submerged sediment samples will be selected from the areas that exhibit the highest levels of contaminants.

Specific calculations for data validation for soil sample selection are as follow:

Shell Manufacturing Area - 22 soil samples (including duplicates)

$$(22/67) (100) = 32.84\% (8) = 2.63 (3 \text{ samples}).$$

Mercury Fulminate Facility - 7 soil samples (including duplicates)

$$(7/67) (100) = 10.45\% (8) = 0.84 (\text{approximately } 1 \text{ sample}).$$

Explosives Storage Ares - 16 soil samples (including duplicates)

$$(16/67) (100) = 23.88\% (8) = 1.91 (\text{approximately } 2 \text{ samples}).$$

Test Pit Area - 2 soil samples.

$$(2/67) (100) = 2.99\% (8) = 0.24 (\text{zero samples}).$$

Blasting Cap Manufacturing Area - 4 soil samples.

$$(4/67) (100) = 5.97 (8) = 0.48 (\text{approximately } 1 \text{ sample}).$$

Buildings 118, 120, and 121 - 3 samples (1 per Building).

$$(1/67) (100) = 1.49\% (8) = 0.12 (\text{zero samples}).$$

Marsh area - 10 soil samples.

$$(10/67) (100) = 14.93\% (8) = 1.19 (\text{approximately } 1 \text{ sample}).$$

Pier - 1 soil sample.

$$(1/67) (100) = 1.49\% (8) = 0.12 (\text{zero samples}).$$

Based on these calculations, three samples from shell manufacturing area, one from the former mercury fulminate facility, two from the explosive storage areas, one from the blasting cap manufacturing area and one from the marsh area will be selected for data validation. Soil samples will be selected from areas that exhibit highest level of contaminants within a given sampling location.

C&T laboratory will submit sufficient supporting data and QA/QC results, to enable the reviewer to adequately evaluate the quality of the data.

In addition, laboratory QA/QC samples associated with the samples selected for validation will also be validated.

5.0 LABORATORY QA/QC PROCEDURES

5.1 ANALYTICAL METHODS

The following analytical methods will be used for this project:

CAC Title 26 Metals analysis by EPA RAS CLP SOW ILM01.0 9/90

- ICP Spectrometry
- Graphite Furnace AA Spectrometry
- Cold Vapor AA Spectrometry
- Moisture & pH determination

Chlorinated Pesticides and PCB's by EPA CLP Organics SOW 2/88.

Total Petroleum Hydrocarbons by DHS method 10/89.

Total Volatile and Aromatic Hydrocarbons by DHS method 10/89.

Total Oil and Grease by EPA Method 413.1 as modified for soil

5.2 PARAMETERS & DETECTION LIMITS

Metallic and pesticide parameters are those appearing on the CLP TAL and Target Compound Lists (TCL).

Petroleum hydrocarbons, benzene, toluene, xylene, and thyl benzene (BTX&E), and oil and grease detection limits are those specified by the State Water Resources Control Board in the LUFT Manual (1989).

5.3 DATA DELIVERABLES

C&T will deviate from the CLP procedures in the format of the hardcopy data package. The laboratory will generate, collect, and evaluate all data, and meet all QC criteria specified in the relevant SOW. The laboratory will organize hardcopy data packages equivalent, although not identical to, the deliverable packages specified in the SOW. All raw data including chromatogram, quantitation reports, and instrument output will be submitted. Data packages will be organized systematically and each page will be numbered. The organization of the data packages is outlined below. The laboratory will not supply CLP diskette deliverable data.

5.4 QUALITY ASSURANCE SPECIFICATION

The objective of the laboratory QA procedures is to generate accurate data of known quality. Specifications for QA/QC measurements are clearly defined in the SOW. The laboratory will document compliance with CLP specifications for all samples in the project, and produce monthly trend analysis reports of the following parameters from the project results database:

- Detection Limit Standards
- Laboratory Control and PE Samples
- Initial and Continuing Calibrations
- Calibration Source and Working Standard Traceability
- Matrix Spike Recoveries and Spiking Levels
- Surrogate Spike Recovery Specifications
- Preparation, Method, and Instrument Blanks

5.5 CHAIN OF CUSTODY, DOCUMENT CONTROL, STANDARD OPERATING PROCEDURES

Controlling evidence is an essential part of the laboratory data generation process. Procedures are outlined for these aspects of the project in the CLP SOW's and will be followed according to CLP RAS procedures.

5.6 INORGANIC ANALYSIS

Sample Matrices: Low Concentration Soil and Water Samples.

Analytical Procedures: Follow procedures outlined in EPA document, SOW for Inorganica Analytes, Multi-Media, Multi-Concentration (1988a)

Holding Times: Mercury (26 days) and Metals (180) days.
Cyanide (14 days)

Sample Preservation and Storage: All samples will be preserved in the field by acidification with nitric acid to a pH of 2 or lower. If only dissolved mercury is to be determined, the sample will be filtered before addition of acid.

All samples will be stored at 4°C until analysis and data validation are completed or 90 days after completion of analysis whichever is less.

Target Analyte, Instrument Detection Limit (CRDL) for Metals: Target analyte instrument detection limits for metals are listed in Table 5-1.

TABLE 5-1 ANALYTICAL METHOD AND INSTRUMENT DETECTION LIMITS FOR METALS

METAL	METHOD	INSTRUMENT DETECTION LIMIT (ug/L)
Aluminum	ICP - EPA METHOD 6010	200
Antimony	Same as above.	60
Arsenic	GF-AA	10
Barium	ICP - EPA METHOD 6010	200
Beryllium	Same as above.	5
Cadmium	Same as above.	5
Calcium	Same as above.	5000
Chromium	Same as above.	10
Cobalt	Same as above.	50
Copper	Same as above.	25
Iron	Same as above.	100
Lead	GF-AA - EPA METHOD 7421	3
Magnesium	ICP - EPA METHOD 6010	5000
Manganese	Same as above.	15
Mercury	CV-AA - EPA METHOD 7471	0.2
Molybdenum	ICP - EPA METHOD 6010	80
Nickel	Same as above.	40
Potassium	Same as above.	5000
Selenium	GF-AA METHOD 7740	5
Silver	ICP - EPA METHOD 6010	10
Sodium	Same as above.	5000
Thallium	GF-AA METHOD 7841	10

TABLE 5-1 (Continued)

METAL	METHOD	INSTRUMENT DETECTION LIMIT (ug/L)
Vanadium	Same as above.	50
Zinc	Same as above.	20

Inorganic Deliverables: The basic outline for organization and content of hardcopy data packages for inorganics is as follows:

For all metallic analytes with each batch, sample delivery group (SDG):

Cover Page: client and laboratory sample ID's, directors release
Case Narrative: Batchwise summary of QC data compliance
Chain of Custody Documentation: Traffic report
Summary results of sample analysis: ICP, GF-AA, CF-AA, Moist, and pH
Initial and Continuing Calibration Verification results form
ICP Interference Check Standard Results Form
Spike Sample (MS) Recovery Results Form
Duplicate Sample & %RPD Results Form
Laboratory Control Sample Results Form
GF-AA Post Digest Standard Addition Results Form
Sample Preparation and Analysis Run Logs
Standard Solutions Sources
ICP, GF-AA, CV-AA, moisture, and pH raw data

Quarterly QC Data Forms:

ICP, CV-AA, and GF-AA Instrument Detection Limit determinations
ICP Interelement correction factor determinations
Linear range of calibration GF-AA, CV-AA and ICP

5.7 ORGANIC ANALYSIS

Analytical Procedures: Follow procedures for Pesticides outlined in EPA SOW for Organic Analytes, Multi-Media, Multi-Concentration (1988b).

Total Petroleum Hydrocarbons: LUFT Manual

Data Calculations and Reporting Limits: Data will be reported in units appropriate to the matrix as expressed in the MDL's tables. For soil samples, moisture will be determined and results will be expressed on a dry weight basis. All records of analysis and calculations will be submitted sufficient to recalculate all sample concentrations and QC results. Data will be reported in accordance with the EPA's Documentation Requirements for Data Validation of Non-CLP Laboratory Data for Organic and Inorganic Analyses (1988c)

5.7.1 Pesticides

Sample Matrices: Low concentration soil samples.

Holding Times: Solids: 14 days Extraction/40 days analysis

Sample Storage: All samples will be stored at 4°C protected from light until analysis and data validation are completed or 90 days after completion of analysis whichever is less.

Documentation and Deliverables: Report documentation and all data for sample, Blank, LCS, and MS results will be submitted in CLP simulated format. Forms equivalent to RAS Pesticides Analysis forms I, II, III, IV, VI, VII, VIII, IX, and X will be generated. For each batch (SDG) of Pesticides analyses, for each column (analysis and confirmatory as appropriate.

- Cover: Client and Laboratory sample ID's Directors release
- Case Narrative: Summary of batch QC specification compliance
- Chain of Custody Documentation: Traffic report
- Summary results of sample analysis for pesticides and PCB's
- Surrogate Recovery Summary Form
- Lab Control Sample Recovery Form
- Method Blank Summary Results Form
- Initial Calibration Summary of single components (pesticides)
- Continuing Calibration Verification Summary
- Instrument Run Sequence Log
- Sample Preparation Log
- Raw data: Sample, Calibration and GPC chromatogram

Pesticides Target Compound List: Table 5-2 lists Pesticides Target Compound detection limits.

TABLE 5-2 CAS NUMBER AND METHOD DETECTION LIMIT FOR
ORGANIC PESTICIDE TARGET COMPOUNDS ¹

PESTICIDES	CAS NUMBER	METHOD DETECTION LIMIT (CRQL) SOIL (ug/kg)
SINGLE COMPONENTS:		
a-BHC	319-84-6	8.0
b-BHC	319-85-7	8.0
d-BHC	319-86-9	8.0
g-BHC (Lindane)	58-89-9	8.0
Heptachlor	76-44-8	8.0
Aldrin	309-99-2	8.0
Heptachlor Epoxide	1024-57-3	8.0
Endosulfan-I	959-98-8	8.0
Dieldrin	60-57-1	16.0
4-4'-DDE	72-55-9	16.0
Endrin	72-20-8	16.0
Endosulfan-II	33213-65-9	16.00
4-4'-DDD	72-54-8	16.0
Endosulfan Sulfate	1031-07-8	16.0
4-4'-DDT	50-29-3	16.0

¹ Specific quantitation limits are highly matrix dependent. The quantitation limits listed herein are provided for guidance and may not always be achievable.

TABLE 5-2 (Continued)

PESTICIDES	CAS NUMBER	METHOD DETECTION LIMIT (CRQL) SOIL (ug/kg)
Methoxychlor	72-43-5	80.0
Endrin Ketone	53494-70-5	16.0
a-Chlordane	5103-71-9	80.0
g-Chlordane	5103-74-2	80.0
MULTIPLE COMPONENTS:		
Toxaphene	8001-35-2	160.0
AR-1016	12674-11-2	80.0
AR-1221	11104-28-2	80.0
AR-1232	11141-16-5	80.0
AR-1242	53469-21-9	80.0
AR-1248	12672-29-6	80.0
AR-1254	11097-69-1	160.0
AR-1260	11096-82-5	160.0

5.7.2 Petroleum Hydrocarbon (TPH)

Extraction Method: The Extraction method employed will be as specified in LUFT Manual rather than according to the headspace method.

Holding Time: 14 days.

Petroleum Hydrocarbon Detection Limits: Petroleum Hydrocarbon detection limits are listed in Table 5-3.

TABLE 5-3 Petroleum Hydrocarbon Detection Limits (Volatiles and Extractables)

PETROLEUM COMPONENTS	ANALYTICAL METHOD	METHOD DETECTION LIMIT (mg/kg)
Gasoline	EPA 8015 modified	1.0
Diesel (Kerosene)	Same as above.	1.0

Surrogate Spiking: Hexacosane (C26) added to all samples soils at 5.0 mg/kg, and waters at 250 ug/L. Acceptable recoveries are 75-125%. Corrective action requires reanalysis for surrogate recoveries outside this range.

TPH Calibration Procedures and Criteria: Calibrate according to LUFT Manual procedures with the following specifications:

- Five Point Initial calibration with low standard at the method detection limit (MDL) level.
- Continuing (daily) calibration at Mid Point concentration.
- Less than 25% RSD for both initial and continuing calibration response factors (RFs) of all components.

TPH ANALYSIS QC SPECIFICATIONS

Method Blanks: Analyzed at a frequency of one in each 20 samples or fewer. Acceptable criteria requires blanks to be free of interferences at or below MDLs.

Laboratory Control Samples(LCS): One LCS containing Diesel 5.0 ppm soil and/or 500 ppb water will be analyzed with each batch of 20 or fewer samples. Acceptance criteria require results to be within 75-125% of true value.

Matrix Spike (MS): One MS containing diesel at 5.0 ppm soil and/or 500 ppb water will be analyzed with each batch of 20 or fewer samples. Acceptance criteria requires result to be within 60-125% of true value.

5.7.3 Volatile Aromatic Hydrocarbons (TVH/BTX&E)

Purge and Trap Extraction Method: The Purge and Trap Extraction Method specified in LUFT Manual procedures rather than headspace method will be employed. Detection limits for TVH and BTX&E are listed in Table 5-4.

TABLE 5-4 Volatile Aromatic Hydrocarbon (TVH/BTX&E) Detection Limits

PETROLEUM COMPONENT	ANALYTICAL METHOD	METHOD DETECTION LIMIT (ug/kg)
Benzene	EPA 8020	5.0
Toluene	Same as above.	5.0
Xylene	Same as above.	15.0
Ethyl Benzene	Same as above.	5.0
Total Volatile Hydrocarbons	EPA 8015 modified	1,000

TVH/BTX&E Surrogate Spiking: Bromofluorobenzene and Trifluorotoluene are added to all samples soils at 25.0 ug/kg. Acceptable recoveries are 75-125%. Corrective action requires reanalysis for surrogate recoveries outside this range.

TVH/BTX&E Calibration Procedures and Criteria: Calibrate according to LUFT Manual procedures with following specifications:

- Five Point Initial calibration with low standard at the MDL level.
- continuing (daily) calibration at Mid Point concentration.
- Less than 25% RSD for both initial and continuing calibration response factors (RF's) of all components.

TVH/BTX&E ANALYSIS QC SPECIFICATIONS:

Method Blanks: To be analyzed at a frequency of one in each 20 samples or fewer. Acceptance criteria require blanks to be free of interferences at or below MDL's.

Laboratory Control Samples: One LCS containing BTX&E 15.0 ppb soil and/or 10 ppb water will be analyzed with each batch of 20 or fewer samples. Acceptance criteria require result to be within 75-125% of true value.

Matrix Spike: One MS containing BTX&E at 15.0 ppb soil and/or 10 ppb water will be analyzed with each batch of 20 or fewer samples. Acceptance criteria require result to be within 60-125% of true value.

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Appendix A - Summary of Previous Soil Sampling Analytical Results

ANALYTICAL RESULTS FOR
SOIL SAMPLES COLLECTED BY DHS AND CH2M HILL
1981 THROUGH 1988

BORING NUMBER (0 - 3 FEET)	DATE SAMPLED	2-CHLORO- PHENOL		2-CHLORO- PHENOL		2-NITRO- PHENOL		2,4-DIMETHYL PHENOL		2,4-DIMETHYL PHENOL		2,4-DICHLOR- PHENOL		4-CHLORO- 3-METHYL PHENOL		2,4,6- TRICHLORO- PHENOL	
		MG/KG (EPA 8270)	DETECTION LIMIT	MG/KG (EPA 8270)	DETECTION LIMIT	MG/KG (EPA 8270)	DETECTION LIMIT	MG/KG (EPA 8270)	DETECTION LIMIT	MG/KG (EPA 8270)	DETECTION LIMIT	MG/KG (EPA 8270)	DETECTION LIMIT	MG/KG (EPA 8270)	DETECTION LIMIT	MG/KG (EPA 8270)	DETECTION LIMIT
BF1-COMP.	04/28/90	ND	0.33	ND	0.33	ND	1.650	ND	0.330	ND	0.330	ND	1.650	ND	0.330	ND	0.330
BF2-COMP.	04/28/90	ND	0.33	ND	0.33	ND	1.650	ND	0.330	ND	0.330	ND	1.650	ND	0.330	ND	0.330
BF3-COMP.	04/28/90	ND	0.33	ND	0.33	ND	1.650	ND	0.330	ND	0.330	ND	1.650	ND	0.330	ND	0.330

BORING NUMBER (0 - 3 FEET)	DATE SAMPLED	2,4-DINITRO PHENOL		4-NITRO- PHENOL		2-METHYL- 1,4,6-DINITRO- PHENOL		PENTA- CHLORO- PHENOL		2-METHYL- PHENOL		2-METHYL- PHENOL		4-METHYL- PHENOL		2,4,5-TRI- CHLORO- PHENOL	
		MG/KG (EPA 8270)	DETECTION LIMIT	MG/KG (EPA 8270)	DETECTION LIMIT	MG/KG (EPA 8270)	DETECTION LIMIT	MG/KG (EPA 8270)	DETECTION LIMIT	MG/KG (EPA 8270)	DETECTION LIMIT	MG/KG (EPA 8270)	DETECTION LIMIT	MG/KG (EPA 8270)	DETECTION LIMIT	MG/KG (EPA 8270)	DETECTION LIMIT
BF1-COMP.	04/28/90	ND	1.650	ND	1.650	ND	1.650	ND	1.650	ND	0.330	ND	0.330	ND	0.330	ND	1.650
BF2-COMP.	04/28/90	ND	1.650	ND	1.650	ND	1.650	ND	1.650	ND	0.330	ND	0.330	ND	0.330	ND	1.650
BF3-COMP.	04/28/90	ND	1.650	ND	1.650	ND	1.650	ND	1.650	ND	0.330	ND	0.330	ND	0.330	ND	1.650

BORING NUMBER (0 - 3 FEET)	DATE SAMPLED	MERCURY		COPPER		ZINC		ARSENIC		CHROMIUM		SULFATE		NITRATE	
		MG/KG	DETECTION LIMIT (EPA 7471)	MG/KG	DETECTION LIMIT (EPA 3050/6010)	MG/KG	DETECTION LIMIT (EPA 3050/6010)	MG/KG	DETECTION LIMIT (EPA 6010)	MG/KG	DETECTION LIMIT (EPA 6010)	MG/KG	DETECTION LIMIT (EPA 300.0)	MG/KG	DETECTION LIMIT (EPA 300.0)
B34-COMP.	01/17/90	7	DL. 1.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B35-COMP.	01/19/90	3	DL. 1.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	18	D.L. 10
B36-COMP.	01/17/90	0.23	DL. 0.1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B37-COMP.	01/19/90	0.73	DL. 0.1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	13	D.L. 10
B38-COMP.	01/19/90	2.5	DL. 1.0	200	DL. 1.0	170	DL. 0.50	NA	NA	NA	NA	NA	NA	NA	NA
B39-COMP.	01/19/90	6.7	DL. 1.0	160	DL. 1.0	180	DL. 0.50	NA	NA	NA	NA	NA	NA	NA	NA
B40-COMP.	01/19/90	2.7	DL. 1.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	11	D.L. 10
B41-COMP.	01/19/90	0.34	DL. 0.10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B42-COMP.	01/19/90	0.16	DL. 0.10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B43-COMP.	01/19/90	1.6	DL. 0.10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B44-COMP.	01/19/90	1.0	DL. 0.10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B45-COMP.	01/19/90	6.1	DL. 1.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B46-COMP.	02/19/90	14	DL. 1.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B47-COMP.	02/19/90	4.7	DL. 1.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B48-COMP.	02/19/90	0.41	DL. 0.10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B49-COMP.	02/19/90	0.32	DL. 0.10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SS1(B6)	02/19/90	3.9	DL. 1.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SS2(B3)	02/19/90	4.7	DL. 1.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SS3(B12)	02/19/90	90	DL. 10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SS4(B18)	02/19/90	240	DL. 20	140	DL. 0.50	270	DL. 0.50	NA	NA	NA	NA	NA	NA	NA	NA
SS5(B16)	02/19/90	24	DL. 10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SS6(B20)	02/19/90	1.2	DL. 0.10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SS7(B10)	02/19/90	21	DL. 10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SS8(B37)	02/19/90	13	DL. 10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SS9(B39)	02/19/90	1.1	DL. 1.0	110	DL. 0.50	150	DL. 0.50	NA	NA	NA	NA	NA	NA	NA	NA
SS10(B43)	02/19/90	14	DL. 1.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MWB142	02/24/90	36	DL. 10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MWB3	02/24/90	27	DL. 10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MWB4	02/24/90	24	DL. 10	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
MWB5	02/24/90	2.7	DL. 1.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B71-COMP.	04/28/90	NA	NA	49	DL. 1.0	NA	NA	ND	DL. 2.5	14	DL. 0.50	NA	NA	NA	NA
B72-COMP.	04/28/90	NA	NA	120	DL. 1.0	NA	NA	16	DL. 2.5	14	DL. 0.50	NA	NA	NA	NA
B73-COMP.	04/28/90	NA	NA	32	DL. 1.0	NA	NA	ND	DL. 2.5	12	DL. 0.50	NA	NA	NA	NA

[illegible]

ANALYTICAL RESULTS FOR
SOIL SAMPLES COLLECTED BY JONAS & ASSOCIATES INC.

1989 THROUGH 1990

UCRFS
PESTICIDES AND PCBs
UNIT (PPM)

BORING NO.	DATE SAMPLED	COMPANY SAMPLED	DEPTH (FEET)	ANALYTICAL METHOD	a-BHC	b-BHC	g-BHC	d-BHC	Heptachlor	Aldrin	Heptachlor Epoxide	Endosulfan I
S1-COMP.	11/01/88	CH2M HILL	0 - 2	EPA-608-808	0.01	DL. 0.01	0.01	DL. 0.01	0.01	DL. 0.01	0.01	DL. 0.01
S2-COMP.	11/01/88	CH2M HILL	0 - 2	EPA-608-808	0.01	DL. 0.01	0.01	DL. 0.01	0.01	DL. 0.01	0.01	DL. 0.01
S3-COMP.	11/01/88	CH2M HILL	0 - 2	EPA-608-808	0.01	DL. 0.01	0.01	DL. 0.01	0.01	DL. 0.01	0.01	DL. 0.01
S4-COMP.	11/01/88	CH2M HILL	0 - 2	EPA-608-808	0.01	DL. 0.01	0.01	DL. 0.01	0.01	DL. 0.01	0.01	DL. 0.01
S5-COMP.	11/01/88	CH2M HILL	0 - 2	EPA-608-808	0.01	DL. 0.01	0.01	DL. 0.01	0.01	DL. 0.01	0.01	DL. 0.01
BORING NO.	DATE SAMPLED	COMPANY SAMPLED	DEPTH (FEET)	ANALYTICAL METHOD	Dieldrin	4,4-DDE	Endrin	Endosulfan II	4,4-DDD	Endrin Aldehyde	Endosulfan Sulfate	4,4-DDT
SSL011A	06/24/82	DHS	MARSH	GC AT ECS	MA	MD	MA	MA	MD	MA	MA	MD
SSL011C	06/24/82	DHS	?	GC AT ECS	MA	MD	MA	MA	MD	MA	MA	MD
S1-COMP.	11/01/88	CH2M HILL	0 - 2	EPA-608-808	0.02	DL. 0.02	0.02	DL. 0.02	0.02	DL. 0.02	0.02	DL. 0.02
S2-COMP.	11/01/88	CH2M HILL	0 - 2	EPA-608-808	0.02	DL. 0.02	0.02	DL. 0.02	0.02	DL. 0.02	0.02	DL. 0.02
S3-COMP.	11/01/88	CH2M HILL	0 - 2	EPA-608-808	0.02	DL. 0.02	0.02	DL. 0.02	0.02	DL. 0.02	0.02	DL. 0.02
S4-COMP.	11/01/88	CH2M HILL	0 - 2	EPA-608-808	0.02	DL. 0.02	0.02	DL. 0.02	0.02	DL. 0.02	0.02	DL. 0.02
S5-COMP.	11/01/88	CH2M HILL	0 - 2	EPA-608-808	0.02	DL. 0.02	0.02	DL. 0.02	0.02	DL. 0.02	0.02	DL. 0.02

BORING NO.	DATE SAMPLED	COMPANY SAMPLED	DEPTH (FEET)	ANALYTICAL METHOD	Chlordane	Toxaphene	PCB-1221	PCB-1232	PCB-1242	PCB-1016	PCB-1248
S1-COMP.	11/01/88	CH2M HILL	0 - 2	EPA-608-808	<0.1	<0.2	DL. 0.2	<0.1	DL. 0.1	<0.1	DL. 0.1
S2-COMP.	11/01/88	CH2M HILL	0 - 2	EPA-608-808	<0.1	<0.2	DL. 0.2	<0.1	DL. 0.1	<0.1	DL. 0.1
S3-COMP.	11/01/88	CH2M HILL	0 - 2	EPA-608-808	<0.1	<0.2	DL. 0.2	<0.1	DL. 0.1	<0.1	DL. 0.1
S4-COMP.	11/01/88	CH2M HILL	0 - 2	EPA-608-808	<0.1	<0.2	DL. 0.2	<0.1	DL. 0.1	<0.1	DL. 0.1
S5-COMP.	11/01/88	CH2M HILL	0 - 2	EPA-608-808	<0.1	<0.2	DL. 0.2	<0.1	DL. 0.1	<0.1	DL. 0.1

UCRFS

METAL ANALYSIS

UNIT (PPM)

BORING NO.	DATE SAMPLED	COMPANY SAMPLED	DEPTH (FEET)	ANALYTICAL METHOD	Silver	Arsenic	Barium	Bismuth	Bromine	Cadmium	Cobalt	Chromium TOTAL	Cesium	Copper	Iron	Mercury	Iodine	Manganese
1	1981																	
2	1981																	
3	1981																	
4	1981																	
5	1981																	
6	1981																	
SSL 001B	1982	DHS			MD	16 +/-4	157 +/-36	MD	MD	MD	MD	MD	MD	349	13700	MD	MD	485
SSL 001Cs	1982	DHS			MD	MD	90 +/-36	MD	MD	MD	MD	MD	MD	208	14900	MD	MD	114 +/-28
SSL 002B	1982	DHS			MD	37 +/-8	110 +/-34	MD	MD	MD	MD	MD	MD	341	26800	MD	MD	218 +/-36
SSL 002C	1982	DHS			MD	MD	124 +/-36	MD	MD	MD	MD	32 +/-22	MD	49 +/-8	14200	MD	MD	389
SSL 005B	1982	DHS			MD	21 +/-8	133 +/-34	MD	MD	MD	MD	MD	MD	152	13100	MD	MD	908
SSL 005C	1982	DHS			MD	MD	137 +/-36	MD	MD	47 +/-12	MD	43 +/-24	MD	MD	16700	MD	MD	453
SSL 004B1	1982	DHS			MD	19 +/-6	126 +/-36	MD	MD	MD	MD	30 +/-24	MD	20 +/-6	15900	MD	MD	365
SSL 004B2	1982	DHS			MD	16 +/-4	42 +/-36	MD	MD	MD	MD	35 +/-24	MD	21 +/-6	17000	MD	MD	318
SSL 004Cs	1982	DHS			MD	MD	111 +/-36	MD	MD	MD	MD	36 +/-24	MD	17 +/-6	16000	MD	MD	293
SSL 006Cs	1982	DHS			MD	MD	135 +/-36	MD	MD	MD	MD	34 +/-22	MD	MD	14200	MD	MD	365
SSL 007B	1982	DHS			MD	33 +/-18	213 +/-38	MD	MD	MD	MD	135 +/-30	MD	452	24200	MD	MD	108 +/-34
SSL 008B	1982	DHS			MD	15 +/-6	144 +/-36	MD	MD	MD	MD	MD	MD	86	18300	MD	MD	343
SSL 009B	1982	DHS			MD	26 +/-6	232 +/-38	MD	MD	MD	MD	MD	MD	359	27000	MD	MD	438
SSL 010A	1982	DHS			MD	21 +/-4	290 +/-34	MD	MD	MD	MD	41 +/-24	MD	577	17700	MD	MD	314
SSL 010Cs	1982	DHS			MD	11 +/-4	94 +/-34	MD	MD	47 +/-12	MD	MD	MD	MD	11900	MD	MD	127
SSL 011A	1982	DHS			MD	84	108 +/-34	MD	MD	MD	MD	MD	MD	113	34500	MD	MD	306 +/-40
SSL 011C	1982	DHS			MD	283	MD	MD	MD	MD	MD	MD	MD	149	50200	MD	MD	72 +/-14
S1-COMP.	11/01/88	CH2M HILL	0 - 2	(6010; 7471)	MD	18	DL 2.4	MD	MD	MD	MD	24.6	DL. 0.6	223	DL. 0.6	260*	DL. 0.06	482
S2-COMP.	11/01/88	CH2M HILL	0 - 2	(6010; 7471)	MD	13	DL 2.4	MD	MD	MD	MD	30.9	DL. 0.6	47.5	DL. 0.6	0.53	DL. 0.06	533
S3-COMP.	11/01/88	CH2M HILL	0 - 2	(6010; 7471)	MD	4.4	DL 2.4	MD	MD	MD	MD	92.1	DL. 0.6	16	DL. 0.6	0.34	DL. 0.06	554
S4-COMP.	11/01/88	CH2M HILL	0 - 2	(6010; 7471)	MD	5.5	DL 2.4	MD	MD	MD	MD	44.7	DL. 0.6	15	DL. 0.6	0.39	DL. 0.06	749
S5-COMP.	11/01/88	CH2M HILL	0 - 2	(6010; 7471)	MD	4.8	DL 2.4	MD	MD	MD	MD	49.0	DL. 0.6	24.2	DL. 0.6	0.38	DL. 0.06	819
S6-COMP.	11/01/88	CH2M HILL	0 - 2	(6010; 7471)	MD	2.8	DL 2.4	MD	MD	MD	MD	28.3	DL. 0.6	15	DL. 0.6	0.07	DL. 0.06	372

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UCRFS
PESTICIDES AND PCBs
UNIT (PPM)

BORING NO.	DATE SAMPLED	COMPANY	DEPTH (FEET)	ANALYTICAL METHOD	PCB-1254	PCB-1260
S1-COMP.	11/01/88	CH2M HILL	0 - 2	EPA-608-808	<0.2	DL. 0.2
S2-COMP.	11/01/88	CH2M HILL	0 - 2	EPA-608-808	<0.2	DL. 0.2
S3-COMP.	11/01/88	CH2M HILL	0 - 2	EPA-608-808	<0.2	DL. 0.2
S4-COMP.	11/01/88	CH2M HILL	0 - 2	EPA-608-808	<0.2	DL. 0.2
S5-COMP.	11/01/88	CH2M HILL	0 - 2	EPA-608-808	<0.2	DL. 0.2

Appendix B - Copies of Specific Documents Reviewed (Listed in Table 1-1)



ecology and environment, inc.

160 SPEAR STREET, SAN FRANCISCO, CALIFORNIA 94105, TEL. 415.777.2811

International Specialists in the Environment

SCREENING SITE INSPECTION REASSESSMENT

SUBMITTED TO: Paul La Courreys, Site Screening Coordinator
EPA Region IX

PREPARED BY: Matthew Williams, Ecology and Environment, Inc. *MBW*

THROUGH: Paul Brown, Ecology and Environment, Inc. *PAB*

DATE: February 16, 1990

SITE: University of California, Berkeley
Richmond Field Station
prepared by Rick Dreessen, ICF Technology,
dated March 28, 1988

TDD#: F9-9002-004

EPA ID#: CAD980673628

PROGRAM ACCOUNT#: FCA1442SAA

FIT REVIEW/CONCURRENCE: *James M. James 2/16/90*

cc: FIT Master File
Don Plain, CA Dept. of Health Services
Dave Mowday, EPA Region IX

INTRODUCTION

The U.S. Environmental Protection Agency, Region IX, has tasked Ecology and Environment, Inc.'s field Investigation Team (FIT) to reassess all sites with completed Screening Site Inspections (SSI) in the Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) database that are still being considered for further action. The strategy for determining whether these SSIs actually merit further action is based primarily on each site's potential to achieve a score high enough on the proposed revised Hazard Ranking System (rHRS) for inclusion on the National Priorities List (NPL). This strategy is intended to identify those sites posing the highest relative risk to human health or the environment. All other sites needing remedial or enforcement follow-up will be referred to the states or an appropriate federal authority. Actions and involvement by authorities other than the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) will also be considered.

mw/rfs/si-re

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SUMMARY

The Richmond Field Station of the University of California at Berkeley (RFS) consists of 160 acres located on the northeastern shore of the San Francisco Bay (1). The site is bordered on the east by the former site of Stauffer Chemical Company (Stauffer), now ICI Americas Incorporated. The south edge is formed by approximately 60 acres of marshland belonging to the RFS, which are in turn bordered by the San Francisco Bay. To the north and west of the RFS lie incorporated areas of the City of Richmond.

The University purchased the site in 1950 from Cal Cap, an explosives manufacturing firm (2). Cal Cap purchased part of the site from the Hercules Powder Company in 1900, and continued to acquire parts of the current field station from smaller explosives manufacturers. By 1920 Cal Cap was the sole manufacturer of explosives at the site (3). The site is believed to have been used for the manufacture of explosives since 1850 (3).

It is known that Cal Cap used mercury fulminate, a Class A explosive (RCRA waste number P065)(2,3,4). Fulminates are highly sensitive to heat, impact, and friction when dry, and are usually stored wet. In the manufacture of fulminates, toxic and flammable fumes are given off. Care is required in the manufacturing process to ensure that fulminate dust does not escape in the facility exhaust system, which allows explosive deposits to be formed (4). Common fulminate salts used in the manufacture of explosives are copper fulminate, silver fulminate, and mercury fulminate (4). Mercury fulminate gives off fumes of mercury and nitrogen oxides when heated (4).

When the University purchased the property, Cal Cap agreed to remove all hazardous materials on site, but when the University burned parts of the site between 1950 and 1953 to clear the vegetation, several explosions occurred (2). The explosions indicate that fulminate dust may have accumulated on site (4).

In 1980 the California Department of Fish and Game, the California Occupational Safety and Health Administration, San Pablo Sanitary District, and the University became concerned that the site might be contaminated with mercury (3). In 1981 soil sampling was initiated as part of an Abandoned Site Project study by the California Department of Health Services (DHS). Twelve soil samples were taken and analyzed for metals and DDT (3). The results of the sample analysis indicated that elevated levels of heavy metals occurred on site, with mercury occurring at 105 ppm, which is above the 20 ppm Total Threshold Limit Concentration (TTLC). DDT was also detected in the marsh adjacent to the Richmond Field Station at a level of 1.7 ppm, which is above the 1.0 ppm TTLC for DDT (2).

The DHS returned in 1982 to take 17 more soil samples in an effort to confirm the 1981 results (2,3). Analysis of the samples did not detect mercury or DDT. However, lead was detected at 985 ppm, which is close to the TTLC for lead, 1000 ppm; elevated levels of copper were also detected. Copper fulminate can be used in the manufacture of explosives,

raising the possibility that copper levels may be indicative of past deposition from Cal Cap's activities (4). Since the results did not seem to agree, the DHS decided that no mercury or DDT contamination had occurred, and the site was removed from consideration as an abandoned hazardous waste site (2).

In 1984 the California Regional Water Quality Control Board requested that the University perform tests on surface run-off, and groundwater (3). Six water samples were taken, and analyzed for heavy metals. The analyses indicated that none of the samples had exceeded federal Maximum Concentration Levels (MCL) for metals (3).

The University initiated its own study of the Richmond Field station in 1988, and retained a consultant to conduct sampling at six areas of the station (3). The consultant collected soil samples which were analyzed for metals, pesticides and volatile organic compounds (VOCs) (3). No pesticides, or VOCs were detected, and metal levels were low over most of the site except for the former mercury fulminate production area (3). Mercury was reported at 260 ppm, greatly exceeding the 20 ppm TTLC (3).

FIT was unable to review the sampling methodologies pursued during these efforts; however, if the presence of mercury on site is due to the deposition of mercury fulminate dust from the Cal Cap ventilation system, then sampling efforts to date do not appear sufficient to characterize the site.

In 1972 Stauffer graded a 15,000 cubic yard landfill containing low-grade cinder and slag waste from a discontinued plant process (5). The cinder and slag waste piles contain leachable acidic metal salts (5). It appears likely that portions of the Stauffer slag piles extended onto the RFS property, but were not graded over in 1972 (6). The cinders appear to have been used for fill in a road that traverses current marsh areas (6). A recent study conducted at the RFS has indicated that the cinder in the road fill may be a cause of high acidity in some areas of the marsh (6). However, this study did not analyze for metals (6).

Other hazardous waste sites in the vicinity of the RFS include the Liquid Gold Oil National Priorities List Site, the Santa Fe lead battery site, and a lead paint dumping ground known as Meeker Ditch (1,3).

The groundwater in the Richmond area is not potable due to the salinity and mineral content of the aquifer (6,7). The City of Richmond receives water from the East Bay Municipal Utilities District, which imports the water from surface water sources in the Sierra Nevada Mountains (8). There are operational private wells within 4 miles of the site, all of which are used for industrial purposes or irrigation (7).

There are three surface water bodies within 2 miles of the site. Potrero Creek, the RFS wetlands, and San Francisco Bay (1,3,9). Potrero Creek rises from underground and enters the RFS wetlands at the facility's western edge. The RFS wetlands form the facility's southern border, and the bay lies just beyond them. Several endangered species are believed to use the RFS wetlands, including the California Clapper Rail, the Brown Pelican, and the Salt Marsh Harvest Mouse (1,3). The Brown Pelican has

been sighted in the RFS wetlands (1). San Francisco Bay is used for commercial and recreational fishing, boating, and water contact recreation. The 2-year 24-hour rainfall in the Richmond area is 2.5 inches (10).

The 1981 DHS sampling effort appears to document a release of mercury from the site to the RFS wetlands. The release of hazardous constituents from the road fill has not yet been investigated except for acidity, which is not sufficient to document an observed release (6). However, the possibility exists that contaminants from the cinders used as road fill are leaching into the marsh.

Despite contaminated soil, and the possibility of aerial deposition of mercury fulminate, no air sampling has been conducted to date. FIT estimates that approximately 150,000 people live/work within 4 miles of the site (10,11).

The Richmond Field Station has between 250 and 300 people employed in various activities on site (12). The sampling efforts conducted in 1981 and in 1988 indicate the presence of mercury in soils well beyond the TTLC for this element. The sampling efforts have not been able to completely characterize the site, although it is likely that the source is the mercury fulminate production area. It can not be ruled out, however, that additional sources may exist in the former blasting cap and shell manufacturing areas (3). FIT estimates that 20,000 people live within 1 mile of the site (10,11).

OTHER AUTHORITY INVOLVEMENT

The California Department of Health Services (DHS), the Regional Water Quality Control Board (RWQCB), the California Department of Fish and Game, the San Pablo Sanitary District, the California Department of Occupational Safety and Health (Cal OSHA), and the University of California have all been involved in sampling efforts or oversight at the site. Currently, however, none are active at the site except the University of California, which is in the process of proposing to develop the RFS into a research park. The involvement of local agencies, such as the City of Richmond, in regulating this proposal was not evaluated by FIT.

While not currently involved at the site, the San Francisco Bay Conservation and Development Commission (BCDC) and the U.S. Army Corps of Engineers have oversight authority over wetland areas.

CONCLUSION

Although the University of California at Berkeley's Richmond Field Station may be eligible for the National Priorities List, the site should be re-assessed when the proposed revised HRS becomes final.

Important HRS factors for this site include:

- o An observed release to surface water;

mv/rfs/si-re

CONTACT REPORT

AGENCY/APPLICATION: Contra Costa County		
DEPARTMENT: Richmond Health Center		
ADDRESS/CITY: Richmond		
COUNTY/STATE/ZIP: Contra Costa, California		
CONTACT(S)	TITLE	PHONE
1. Rodger Chin		415-374-3141
2.		
E & E PERSON MAKING CONTACT: Matthew Williams		DATE: 12/21/89
SUBJECT: Groundwater use in the Richmond area		
SITE NAME: Bay Area Environmental		EPA ID#: CAT080014079

Mr. Chin stated that there are a number of groundwater wells in the area of Bay Area Environmental that are used for agricultural purposes. He said that the primary use was for nurseries, but that there was no drinking water use that he was aware of mainly due to the salinity of the aquifer.

been sighted in the RFS wetlands (1). San Francisco Bay is used for commercial and recreational fishing, boating, and water contact recreation. The 2-year 24-hour rainfall in the Richmond area is 2.5 inches (10).

The 1981 DHS sampling effort appears to document a release of mercury from the site to the RFS wetlands. The release of hazardous constituents from the road fill has not yet been investigated except for acidity, which is not sufficient to document an observed release (6). However, the possibility exists that contaminants from the cinders used as road fill are leaching into the marsh.

Despite contaminated soil, and the possibility of aerial deposition of mercury fulminate, no air sampling has been conducted to date. FIT estimates that approximately 150,000 people live/work within 4 miles of the site (10,11).

The Richmond Field Station has between 250 and 300 people employed in various activities on site (12). The sampling efforts conducted in 1981 and in 1988 indicate the presence of mercury in soils well beyond the TTLIC for this element. The sampling efforts have not been able to completely characterize the site, although it is likely that the source is the mercury fulminate production area. It can not be ruled out, however, that additional sources may exist in the former blasting cap and shell manufacturing areas (3). FIT estimates that 20,000 people live within 1 mile of the site (10,11).

OTHER AUTHORITY INVOLVEMENT

The California Department of Health Services (DHS), the Regional Water Quality Control Board (RWQCB), the California Department of Fish and Game, the San Pablo Sanitary District, the California Department of Occupational Safety and Health (Cal OSHA), and the University of California have all been involved in sampling efforts or oversight at the site. Currently, however, none are active at the site except the University of California, which is in the process of proposing to develop the RFS into a research park. The involvement of local agencies, such as the City of Richmond, in regulating this proposal was not evaluated by FIT.

While not currently involved at the site, the San Francisco Bay Conservation and Development Commission (BCDC) and the U.S. Army Corps of Engineers have oversight authority over wetland areas.

CONCLUSION

Although the University of California at Berkeley's Richmond Field Station may be eligible for the National Priorities List, the site should be re-assessed when the proposed revised HRS becomes final.

Important HRS factors for this site include:

- o An observed release to surface water;

mw/rfs/si-re

CONTACT REPORT

AGENCY/APFILIATION: East Bay Municipal Utilities District		
DEPARTMENT:		
ADDRESS/CITY: Richmond		
COUNTY/STATE/ZIP: California		
CONTACT(S)	TITLE	PHONE
1. Karen Allen		415-891-0674
2.		
E & E PERSON MAKING CONTACT: Matthew Williams		DATE: 12/6/89
SUBJECT: Source of drinking water for the city of Richmond		
SITE NAME: Bay Area Environmental		EPA ID#: CAT080014079

Ms. Allen said that the city of Richmond received its water from the San Pablo Reservoir, and that the water came mostly from the Sierra foothills and the Pardee Reservoir.

CONTACT REPORT

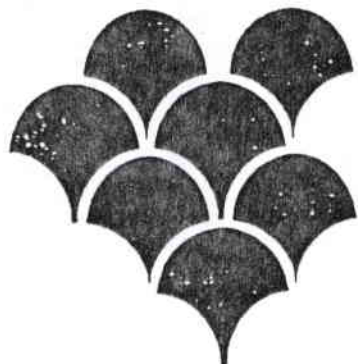
AGENCY/AFFILIATION: University of California at Berkeley		
DEPARTMENT: Campus Planning		
ADDRESS/CITY: Berkeley		
COUNTY/STATE/ZIP: Alameda, California 94720		
CONTACT(S)	TITLE	PHONE
1. Kevin Hufferd		(415) 643-5314
2.		
E & E PERSON MAKING CONTACT: Matthew Williams		DATE: 2/8/90
SUBJECT: Employees at Richmond Field Station		
SITE NAME: U.C. Richmond Field Station		EPA ID#: CAD980673628

Mr. Hufferd stated that he contacted the Richmond Field Station Manager, Mr. Kirkendal, and that they estimated that between 250-300 people work at the Richmond Field Station.

CONTACT REPORT

AGENCY/AFFILIATION: University of California at Berkeley		
DEPARTMENT: Campus Planning		
ADDRESS/CITY: Berkeley		
COUNTY/STATE/ZIP: Alameda. California 94720		
CONTACT(S)	TITLE	PHONE
1. Kevin Hufferd		(415) 643-5314
2.		
E & E PERSON MAKING CONTACT: Matthew Williams		DATE: 2/8/90
SUBJECT: Employees at Richmond Field Station		
SITE NAME: U.C. Richmond Field Station		EPA ID#: CAD980673628

Mr. Hufferd stated that he contacted the Richmond Field Station Manager, Mr. Kirkendal, and that they estimated that between 250-300 people work at the Richmond Field Station.



ensco
environmental
services, inc.

ENVIRONMENTAL ASSESSMENT

OF

UNIVERSITY OF CALIFORNIA
RICHMOND FIELD STATION
RICHMOND, CALIFORNIA

PERFORMED FOR

WALLACE ROBERTS & TODD
121 SECOND STREET, 7TH FLOOR
SAN FRANCISCO, CALIFORNIA 94105

PROJECT NO. 9313ACT
AUGUST 1989

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ENVIRONMENTAL ASSESSMENT

OF

UNIVERSITY OF CALIFORNIA
RICHMOND FIELD STATION
RICHMOND, CALIFORNIA

1.0 INTRODUCTION

Ensco Environmental Services, Inc. (EES), under contract to Wallace Roberts & Todd, conducted a Phase I environmental assessment of the University of California (Berkeley) Richmond Field Station (RFS) located at 1301 South 46th Street in Richmond, Contra Costa County, California. The assessment was performed as part of the University of California's plan to construct a new Research Campus on the undeveloped western portion of the RFS. The new development will include research facilities, a library, and recreational open space.

The assessment evaluated potential environmental liabilities associated with this site and supplemented existing data on the potential existence of hazardous materials and hazardous waste on the site (cited below as Property). The assessment was not required by the California Department of Health Services (DHS), California Regional Water Quality Control Board (RWQCB), or any other local or federal regulatory agency.

The assessment included a Physical Inspection of the Property (Section 3.0) and interviews with personnel familiar with the Property (Section 3.1), a Review of Historical Aerial Photographs (Section 4.0), and an Agency Public Records Review (Section 5.0). Conclusions and Recommendations (Section 6.0) were based on the information gathered from each of these activities. Limitations are provided in Section 7.0.

A Site Location Map (Figure 1) and a General Vicinity Site Map (Figure 2), and soil sample analytical results from former underground storage tank locations on the Property are attached.

2.0 SITE DESCRIPTION

The Property, currently owned and operated by the Regents of the University of California as an engineering field station, is located adjacent to the Richmond Inner Harbor of the San Francisco Bay. It contains 150 acres, approximately 50 acres of which are marshland along its southern border (see Figure 1). Several large chemical and industrial sites border the Property on the north, west, and east. Safeway's distribution center and trucking terminal complex is located north of the RFS. Immediately east of the Safeway terminal is a yard formerly occupied by Pacific Gas & Electric Company and now operated by the California Highway Transportation Department. Bio Rad Laboratories is located west of the RFS. ICI Americas, a large chemical manufacturing facility is adjacent to the Property's eastern border (see Figure 2). Until 1987 ICI Americas was owned by Stauffer Chemical.

Prior to the purchase of the site in 1950 by the University of California, the Property had been subject to many years of industrial activity involving the production of explosives and munitions, and the handling and use of related hazardous materials. These activities can be traced back more than 100 years when several explosives manufacturing companies were located on the eastern portion of the Property. Some time after 1900, California Cap Company (CCC) began purchasing portions of the Property from one of the explosives manufacturers, the Hercules Powder Company. By the 1920's, CCC had acquired additional Property parcels from other small explosives companies, making it the sole manufacturer of explosives on the Property. CCC continued manufacturing explosives until the end of World War II. In 1950 it sold the Property to the University of California. As part of the sale agreement, CCC was required to remove all hazardous materials from the Property. Although CCC reportedly complied with this requirement, the extent of hazardous materials remediation on the Property is not known.

Since its purchase by the University of California, the Property has been used as a research facility for engineering projects, some of which involve the use of hazardous materials. Research work, requiring the storage of equipment, supplies, and laboratory chemicals is conducted in numerous buildings throughout the Property. This assessment will use for identification the building numbers designated by the University of California.

3.0 PHYSICAL INSPECTION OF THE PROPERTY

A physical inspection was conducted on July 10, 1989 to examine the Property for evidence of hazardous waste, improper storage and handling of hazardous materials, and other items of environmental concern. Because of the size of the Property and the large number of buildings located on the RFS, the inspection for storage and handling of hazardous materials was limited to those facilities where hazardous materials are known to be currently utilized and stored. RFS personnel provided EES with a Hazardous Materials Inventory Statement (HMIS) which identified current hazardous materials locations. Locations of potential past hazardous materials are not identified in the current HMIS. The HMIS was prepared in March, 1989 as part of a Hazardous Materials Business Plan for the RFS required by the Hazardous Materials/Occupational Health Division of the Contra Costa County Health Department.

Facilities inspected included Buildings 106, 114, 118, 120, 125, 138, 150, 175, 470, 474, 478 and other buildings and areas where hazardous materials are stored in quantities that currently equal or exceed State and Federal Threshold Planning Quantities. Areas of earlier known hazardous waste activity were also inspected. With the exception of Building 120, no evidence of improper storage or handling of hazardous materials was observed. For the most part, good housekeeping practices regarding the storage of hazardous waste were followed. Laboratory chemicals and cylinders of compressed gases were properly labeled, identified, and secured in storage areas. Hazardous materials storage areas were labeled with appropriate caution signs and "No Smoking" placards.

Building 120 (solvent storage shed) contained approximately twenty 55-gallon drums of thinner, kerosene, and various petroleum hydrocarbon products. Several spills from these drums were observed on the concrete floor of the building and drip pans located underneath the drums were full of product. The spills and drip pans should be cleaned up to prevent any product from impacting soil outside the building.

In addition to the drums inside Building 120, improperly stored or discarded drums were found in three outdoor locations. The first area was located outside the rear wall of Building 120. Approximately twenty unlabeled 55-gallon drums were stacked 3-high against the building wall. Most of the top drums appeared to be empty. However, because of the stacking, it could not be determined if the drums on the bottom were empty or whether the spills from the interior of Building 120 had leaked to the outside. Another six unlabeled 55-gallon drums were found just

outside Building 120 near a small area of stained soil. Several of these were empty, while others contained a mixture of water and unknown product. EES recommends that all of these drums outside Building 120 be removed for proper disposal or recycling. The second outdoor area of concern was located near Building 197, south of a fuel pump island where approximately forty 55-gallon drums and 5-gallon containers of waste oil are stored. These drums and containers should also be removed for proper disposal or recycling. The third area of improper storage was located outside Buildings 118, 121, and 150. These areas contained approximately twenty additional unlabelled 55-gallon drums filled with product. The contents of these drums should be identified by chemical profiling. Afterward, the drums should be consolidated for removal and proper disposal.

Several areas of the Property that are the former sites of explosives manufacturing or storage, and hazardous materials handling were examined for dead or dying vegetation, bare patches of soil, or other evidence of hazardous materials residues. These areas included the former Mercury Fulminate Production Area located in the southwest corner of the Property, the former Explosives Storage Area located south of Wren Drive, the former Blasting Cap Manufacturing Area located on Owl Way, and the former Shell Manufacturing Area located on Heron Drive (see Figure 2).

Several areas of low lying vegetation in the vicinity of the Mercury Fulminate Site appeared stressed and unhealthy. However, no hazardous waste residues were observed.

The explosives storage area contained several large patches of bare soil, but again, no hazardous waste residues were observed. Reddish soils and minimal vegetation were noted at this location. Larry Bell, RFS Project Coordinator, provided a possible explanation for the presence of these red soils. The red soils are thought to be the remains of slag piles used to retard weeds around Property buildings from Stauffer operations. No evidence of stressed vegetation, bare soil patches, or hazardous waste residues was observed in the former Shell Manufacturing Areas. The ground where the Blasting Cap Manufacturing Area existed has been landscaped with imported topsoil, lawn grass, and chemical fertilizer. However, there are noticeable areas where the grasses are not growing. EES' recommendations for soil and groundwater sampling in the Mercury Fulminate Area and Explosives Storage Area are presented in Section 6.0, Conclusions and Recommendations.

3.1 Interviews

Personal interviews with key RFS personnel were conducted by Janet Mack, University of California (Berkeley) Campus Planning Office, to gather additional information regarding use and storage of hazardous materials at RFS facilities. Results of her interviews are summarized below:

- Larry Bell, RFS Project Coordinator

Mr. Bell stated that several underground fuel and solvent storage tanks were previously located near Buildings 119, 154, and 156. These tanks have been excavated and removed from the Property. Soil samples taken from below each tank were analyzed for constituents consistent with the tank contents. Results of the analyses from each tank indicated that contamination of the soil underneath each tank had not occurred. A copy of all analytical results are attached to this report.

A 1300 gallon underground fuel tank is located west of Building 197. This tank is precision tested annually. No evidence of leakage from this tank has been detected since its construction in 1980.

- Antony Oppenheim, Professor Emeritus, Mechanical Engineering

Dr. Oppenheim was interviewed regarding his research work on an explosion chamber. He stated that no chemicals are used as part of his research.

- Mechanical Engineering, Former Ranfied Gas Wind Tunnel

Machinery used in the development of this project ran on steam. Polychlorinated biphenyls (PCB) containing oil was not used as a fuel source or lubricant in this machinery as earlier suspected. No chemicals were stored for this project.

- Institute of Transportation Studies, Bituminous Soils Laboratory

Only very small amounts (approximately 5 gallons) of asphalt are currently stored in facilities involved with this project.

- Everett Howe, Professor Emeritus, Mechanical Engineering, Former Sea Water Conversion Project

Janet Mack, Campus Planning Office, is waiting for information from Dr. Howe.

- Mike Merriman, Specialist, Forest Products Laboratory

The Forest Products Laboratory research facilities are located in Buildings 470-476 on the eastern corner of the Property near South 46th Street. Research on development of wood preservatives and treatment chemicals involved the use of various solvents and other compounds which may contain copper, chromium, and arsenic (CCA) solution, a typical product used in wood preserving. It is suspected that some of these materials have been dumped in the eucalyptus grove immediately behind the laboratory. Soil sampling of this area by the DHS has been scheduled. EES was unable to confirm the completion of this task.

An asphalt pad located between Buildings 472 and 476 was used for storage of solvent containers. Mr. Merriman expressed concern that chemicals may have leaked, penetrated the asphalt pad, and contacted the soil underneath.

Behind Building 470, an experimental furnace, constructed with chrome ore bricks, was used to burn spent pulping liquor. The furnace has been dismantled and the chrome bricks were removed by a licensed contractor. Because of chromium's potential for being a carcinogen, Mr. Merriman also expressed concern regarding the adequacy of the brick rubble cleanup and removal.

After reviewing the results of Ms. Mack's interview with Mr. Merriman, EES staff inspected the area around the Forest Products Laboratory for evidence of hazardous wastes and chemical spills. Chemical leakage on the asphalt pad between Buildings 472 and 476 was not observed. A secured drum storage area located on the asphalt pad was inspected for evidence of leaks or spills. No evidence was observed. Approximately 12 empty 55-gallon drums were found neatly stored in the eucalyptus grove. These containers appeared to be clean and well maintained. No evidence of leakage from these drums was observed.

EES' recommendations for soil sampling in the area surrounding the Forest Products Laboratory are presented in Section 6.0, Conclusions and Recommendations. EES'

understanding is that any soil sampling or remediation of contaminated soil in the Forest Products Laboratory area will be conducted by the University of California (Berkeley) Office of Environmental Health and Safety.

- Dana Crowder, Purchasing and Receiving, RFS

On July 20, 1989 EES interviewed Dana Crowder, an employee of RFS since the early 1950's, regarding the location of former hazardous materials storage and handling areas. Mr. Crowder reviewed historical aerial photographs of the Property supplied by EES and provided historical information regarding activities on the Property just after it was purchased by the University of California. His comments are included in Section 4.0 below.

4.0 REVIEW OF HISTORICAL AERIAL PHOTOGRAPHS

Historical aerial photographs (1985, 1969, 1959, 1947) of the Property and surrounding area were reviewed at Pacific Aerial Surveys in Oakland, California to identify former locations of hazardous materials storage and handling on the Property and adjacent sites. A 1930 map identifying the Property as California Cap Company was also reviewed. This earlier map provided no additional information on the site's history.

1985 Photograph

In a 1985 photograph, obtained from Larry Bell (RFS), the large patches of bare soil were observed in the vicinity of the former Explosives Storage Area, south of Wren Drive. Other areas of bare soil were noted immediately west of Building 167 near an existing water well. Vegetation in the vicinity of the former Blasting Cap Manufacturing Area and Shell Manufacturing Area appeared normal. Near the former Mercury Fulminate Area, bare soil areas were also observed. Sparse vegetation was noticed directly east of the former chrome brick oven near Building 470 of the Forest Products Laboratory. No evidence of hazardous materials dumping was observed in the area around Buildings 470-476.

Since the 1985 photograph was taken, no new development has occurred in the western portion of the Property.

The photograph showed heavy industrial activity on the ICI Americas (formerly Stauffer Chemical) site and the Bio Rad site bordering the Property. A large above ground tank farm on the ICI site was observed along South 46th Street directly east of Building 120 on the Property. According to Dana Crowder, this tank farm was used in the production of sulfuric acid. Large areas of dark and light stains were also observed on the western portion of the ICI site. Four large treatment ponds were located on the southern portion of the ICI site adjacent to marshlands bordering the Richmond Inner Harbor. Railroad tank cars were visible in the center of the ICI site near a large manufacturing complex.

1969 Photograph

In an enlarged 1969 photograph obtained from Pacific Aerial Surveys (No. AV-902-07-08), a large area of barren soil was observed in the vicinity of the former Explosives Storage Area near Wren Drive. Other areas of bare soil were also noted near this location. However, according to Dana Crowder, these areas were the former location of sheds and other small buildings which presumably did not contain explosives or other hazardous materials. Areas of bare soil were not observed in the former Mercury Fulminate Area. Sparse vegetation was observed in the former Blasting Cap Manufacturing Area.

Heavy industrial activity was observed on the ICI Americas site and the Bio Rad site. A large light stain was observed on the ICI Americas site directly south of Building 194 on the Property. The large above ground tank farm was visible east of Building 120. Another above ground tank farm, railroad tank cars, and storage areas of industrial materials were observed on the ICI site.

The western portion of the Property was observed at its current level of development. No evidence of negatively impacted vegetation in this area was observed.

1959 Photograph

In an enlarged 1959 photograph obtained from Pacific Aerial Surveys (No. AV-337-08-12), the Explosives Storage Area near Wren Drive was clearly visible. A large quantity of materials was observed inside the walled storage area. Grounds in the vicinity of the former Blasting Cap Area, Shell Manufacturing Area, and Mercury Fulminate Production Area were undeveloped. It was not possible to determine if these soils were negatively impacted from residual hazardous materials.

The Forest Products Laboratory and the western portion of the Property were undeveloped. The only evidence of previous development on the western portion of the Property was the construction of an unimproved roadway grid.

Industrial activity on the ICI Americas site appeared to be essentially the same as in later photographs. Large spills of a light compound, identified by Dana Crowder as sulfur, were observed in the vicinity of the sulfuric acid tank farm. A large materials storage yard and several large ponds were located near the Richmond Inner Harbor. According to Dana Crowder, waste materials including mercaptans had been dumped into these ponds by Stauffer Chemical.

A large materials storage yard, heavy equipment and large trucks were observed on the Bio Rad site.

1947 Photograph

In an enlarged 1947 photograph obtained from Pacific Aerial Survey (No AV-11-04-05), the former Mercury Fulminate Production Area was observed on the southwest corner of the Property. The walled Explosives Storage Area near Wren Drive was also visible. As in the 1959 photograph, the Forest Products Laboratory was not developed. Details of vegetation patterns and soil quality in other hazardous materials production areas were difficult to see because of the age of the photograph and poor quality due to enlargement.

As in the 1959 photograph, the western portion of the Property was undeveloped. Only unimproved roads appeared on this portion of the Property. Scattered residential housing was observed on the sites currently occupied by Bio Rad Laboratories, Safeway complex, and the Cal Trans Corporation Yard.

The Stauffer Chemical site was less developed. However, the photo did show evidence of heavy industrial activity at the site. The sulfuric acid plant near the Property was less developed. Spills and stains in this area were difficult to observe due to the poor quality from enlargement of the original photo.

5.0 PUBLIC RECORDS REVIEW

To identify potential exposure of the Property to hazardous materials incidents, EES reviewed public records available from local regulatory agencies and geotechnical consultants. Further, because subsurface contamination is capable of migrating in groundwater from nearby sites, public records were also reviewed to determine if toxic spills or fuel leaks have been reported near the Property. Results of the public records review are presented below:

5.1 Contra Costa County Health Services, Hazardous Materials Division (CCCHS)

The most recent listings of unauthorized fuel leaks and reported toxic spills were reviewed at the CCCHS offices in Martinez, California. Reports for all documented incidents involving hazardous materials adjacent to the Property were reviewed. Confirmed toxic spills have been reported for Bio Rad Laboratories, ICI Americas, and Liquid Gold Oil Corporation, a former oil recycler located near ICI Americas. A summary of each case is presented below.

- Bio Rad Laboratories, 32d Street and Regatta Boulevard, Richmond

Bio Rad Laboratories uses radioactive materials in the production of separation technology products. An unknown amount of cobalt 57 was released on the site on August 12, 1987. A formal complaint against Bio Rad was filed with the California Department of Health Services (DHS) on behalf of workers at the site who were exposed to the release and cleanup operations.

Information in the file indicated that contamination by chloroform and acrylamide of a creek located on Bio Rad land had occurred. Although the extent of the spill was not defined, the contamination was consistent with wastes generated by manufacturing processes at Bio Rad.

- ICI Americas, 1415 South 47th Street, Richmond

The ICI Americas currently manufactures sulfuric acid and organic herbicides. EES reviewed a CH₂M Hill report (June 16, 1988) summarizing previous groundwater quality investigation conducted on this site in 1988 by Larry E. Hall, Hydrogeological Associate. According to this report, ICI Americas also manufactures or generates pyrite cinders, fuels, ferric sulfate, pesticides, solvents, and alum. Groundwater monitoring wells were completed on the site and

samples were collected for analyses of priority metals and organic compounds. According to the CH₂M Hill report, the analytical results were difficult to interpret. Units of measurement (parts-per-million vs. parts-per-billion) were unclear.

The CH₂M Hill report also stated that the Regional Water Quality Control Board (RWQCB) requested ICI to perform a hydrogeologic investigation near a closed cinder landfill on the site. A preliminary investigation was completed in 1987. Under a remedial action program designed and implemented by Stauffer Chemical, shallow groundwater contaminated with pesticides was being extracted and treated. The RWQCB also informed Stauffer of the requirements of the Toxic Pits Control Act (TPCA) regarding sampling and cleanup of surface impoundments on this site.

This site has also been cited by Contra Costa County for noncompliance regarding treatment, storage, and disposal of hazardous wastes without appropriate regulatory agency permits.

- Liquid Gold Oil Corporation, Richmond

This site is located approximately 1/2 mile south of the Property, adjacent to ICI Americas. From 1974 until 1982, this site was leased by the Liquid Gold Oil Corporation to store and recycle used oil and other substances. Prior to 1974, the site operated an asphalt manufacturing plant. As a result of these operations, hazardous materials were spilled or leaked onto the ground around storage tanks; were discharged into ponds, sumps, and ditches on the site; and drained into nearby wetlands areas. Soil and groundwater have been contaminated with oil and grease, phenols, lead, nickel, copper, chromium, zinc, PCBs and other compounds. This site is currently listed on State and Federal National Priority Site Lists (Superfund) as an abandoned hazardous waste disposal site.

Southern Pacific Transportation Company owns the land on which this site was located and has assumed all responsibility for cleanup and delisting of this site.

5.2 Regional Water Quality Control Board (RWQCB)

No additional sites within the vicinity of the Property have been reported to this agency.

5.3 California Department of Health Services (DHS)

Extensive soil sampling and analyses of the Property was previously completed by this agency in 1982. The results of these studies indicated low levels of priority metals contamination in soils near the former Explosives Storage Area, Blasting Cap Manufacturing Area, and the undeveloped western portion of the Property. Although these data indicated the presence of metals contamination in varying concentrations on the Property, none of these concentrations exceeded the Total Threshold Limit Concentration (TTLC) established by the DHS for priority metals. Mercury was not detected in any soil samples collected.

5.4 CH₂M Hill Consultants

Additional soil sampling on the Property was conducted by this consulting firm in 1988. Based upon a review of background information concerning the Property and the results of previous soil sampling activities, CH₂M Hill recommended additional soil sampling and installation of groundwater monitoring wells on the Property. Soil sampling was completed in Fall, 1988. The results of this investigation indicated mercury contamination in soils near the former Mercury Fulminate Production Area above the TTLC level for this metal. Analyses of other soil samples from the Property detected low levels of priority metals. Soil samples collected from the undeveloped western portion of the Property were also analyzed for pesticide residues. No pesticides were detected in these samples. Because of the low levels of metals and pesticides found in nearly all soil samples, groundwater monitoring wells were not installed on the Property.

6.0 CONCLUSIONS AND RECOMMENDATIONS

Based upon a physical inspection of the Property and a review of current hazardous materials handling and storage practices, EES has concluded that soils in the vicinity of the Forest Products Laboratory may have been subject to environmental impairment from research activities connected with the Laboratory.

Based upon a review of historical aerial photographs, interviews with key RFS personnel, and a review of available public records, EES has concluded that soils and groundwater under the Property may have been subject to environmental impairment from manufacturing and handling of hazardous materials associated with the long history of industrial activities on the Property and adjacent sites. Previous studies of the Property conducted by the California Department of Health

Services (DHS) and private geotechnical consulting firms have detected varying levels of priority metals in RFS soils. Several soil samples collected from the former Mercury Fulminate Production Area contained mercury above the TTLC level established for this metal by the DHS. Additionally, soil samples collected from the former Explosives Storage Area, Blasting Cap Manufacturing Area, and Shell Manufacturing Area were not analyzed for nitrogen-containing residues. The manufacturing of explosives and munitions typically involves nitrogen-containing compounds. Finally, groundwater under these areas has not been analyzed for nitrogen-containing compounds or volatile organic compounds (VOCs).

Based upon these conclusions, EES recommends the following actions be taken to fully define the extent of contamination of soil and groundwater, if any, under the Property.

Forest Products Laboratory

- Drill one exploratory boring through the asphalt pad between Building 472 and 476 to a depth of 3 feet and collect one soil sample for analyses of pentachlorophenol, arsenic, copper, chromium and VOCs.
- Drill three exploratory borings to a depth of 3 feet immediately behind Building 470 and collect one soil sample from each boring for analysis of chromium.
- Collect two surface soil samples from the shallow ditch, carrying runoff from the asphalt pad, near the former chrome brick oven for analysis of VOCs and solvents.
- Drill one exploratory boring to a depth of 3 feet directly behind the wood preservative test chamber located on the asphalt pad and collect one soil sample for analysis of pentachlorophenol, arsenic, copper, chromium and VOCs.

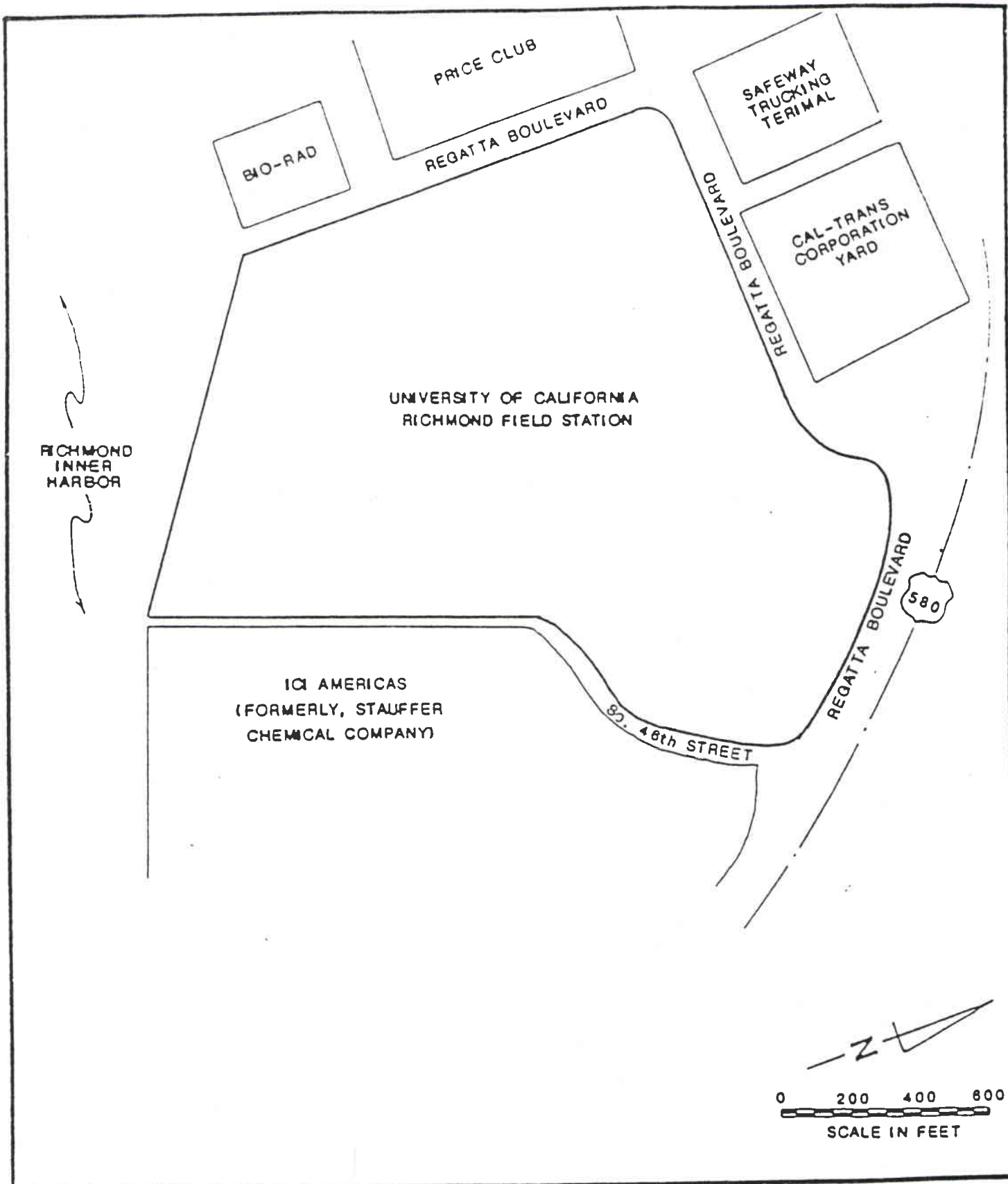
Former Mercury Fulminate Production Area

- Drill a maximum of twenty 5-foot soil borings in an approved grid pattern covering the former Mercury Fulminate Production Area. Collect one soil sample from each boring, analyze each soil sample for mercury residues, continue five of the borings to contact the uppermost water bearing stratum, collect one water sample from each borehole, and analyze each water sample for mercury.

ATTACHMENT A

FIGURE 1 SITE LOCATION MAP

FIGURE 2 GENERAL VICINITY SITE MAP



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GENERAL VICINITY SITE MAP

UNIVERSITY OF CALIFORNIA - RICHMOND FIELD STATION

1301 SOUTH 46TH ST. AND REGATTA BLVD.

RICHMOND, CALIFORNIA

JOB #
9313A

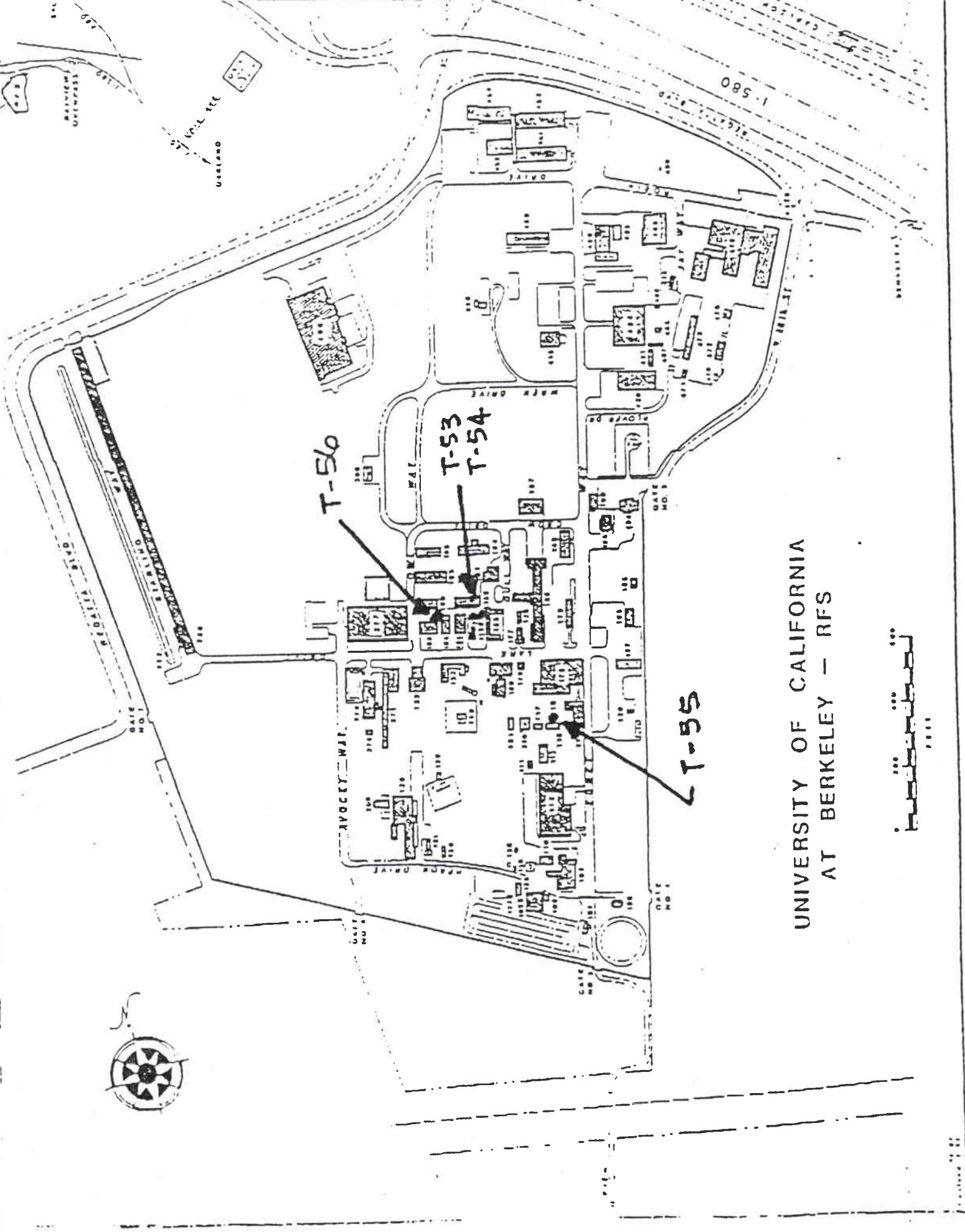
DRAWN BY
SLS

DATE:
8-14-89

DRAWING #
FIG. 2

ATTACHMENT B

SOIL SAMPLE RESULTS
FROM
FORMER UNDERGROUND STORAGE TANKS



UNIVERSITY OF CALIFORNIA
AT BERKELEY - RFS



Thermo Analytical Inc.

TMA/ERG

100-111-1111-1111

TMA/ERG

100-111-1111-1111

TMA/ERG

November 5, 1986

University of California
1301 South 46th St.
Richmond, CA 94804

Attention: Larry Bell

Report #9601

P.O. #7-273848-TR

Re: Three (3) soil samples submitted on November 3, 1986 for
diesel fuel analysis.

Procedure: The samples are analyzed for diesel fuel by following
the method described in Attachment 2, Analytical Procedures for
Fuel Leak Investigations. The samples are concentrated on a
Tekmar LSC-2 automatic sample concentrator prior to injection
into a gas chromatograph fitted with a flame ionization detector.
Quantitation is performed, as total hydrocarbon response, against
known concentrations of heptane-isooctane (45/55). The limit of
detection for this method of analysis is two parts per million
(mg/kg).

The results are displayed in the table below:

<u>TMA/ERG #</u>	<u>CLIENT ID</u>	<u>CONCENTRATION (mg/kg)</u>
9601-1	T-53	ND(2)
9601-2	T-54	4.3
9601-3	T-56	4.7

Submitted by:

Robert A. Flay
Manager, Organics Department

RBF:ml

FACILITIES MANAGEMENT

SOIL TEST
550 GAL. TANK (T-5)

'88 JUL 25 P4:28

UNIV. OF CALIF.
BERKELEY

CLIENT: UC Berkeley - Office of State Architect
STREET: 3000 Carleton
CITY: Berkeley
STATE: CA ZIP: 94720

LAB I.D.: P-56318

PURCHASE ORDER: N/A

COPY TO: O.S.A. - P.O. Box 1225

Sacto, CA 95812 Attn: J. Conde

DATE COLLECTED: June 28, 1988

SAMPLE LOCATION: Richmond Field Station - H

COLLECTED BY: Terry Hamilton

TOTAL PETROLEUM HYDROCARBONS

Compound	Test Methods	Result (ug/kg)	Report Limit (ug/kg)
BENZENE	3810	NO	12
TOLUENE	3810	NO	12
XYLENES (Total)	3810	NO	12

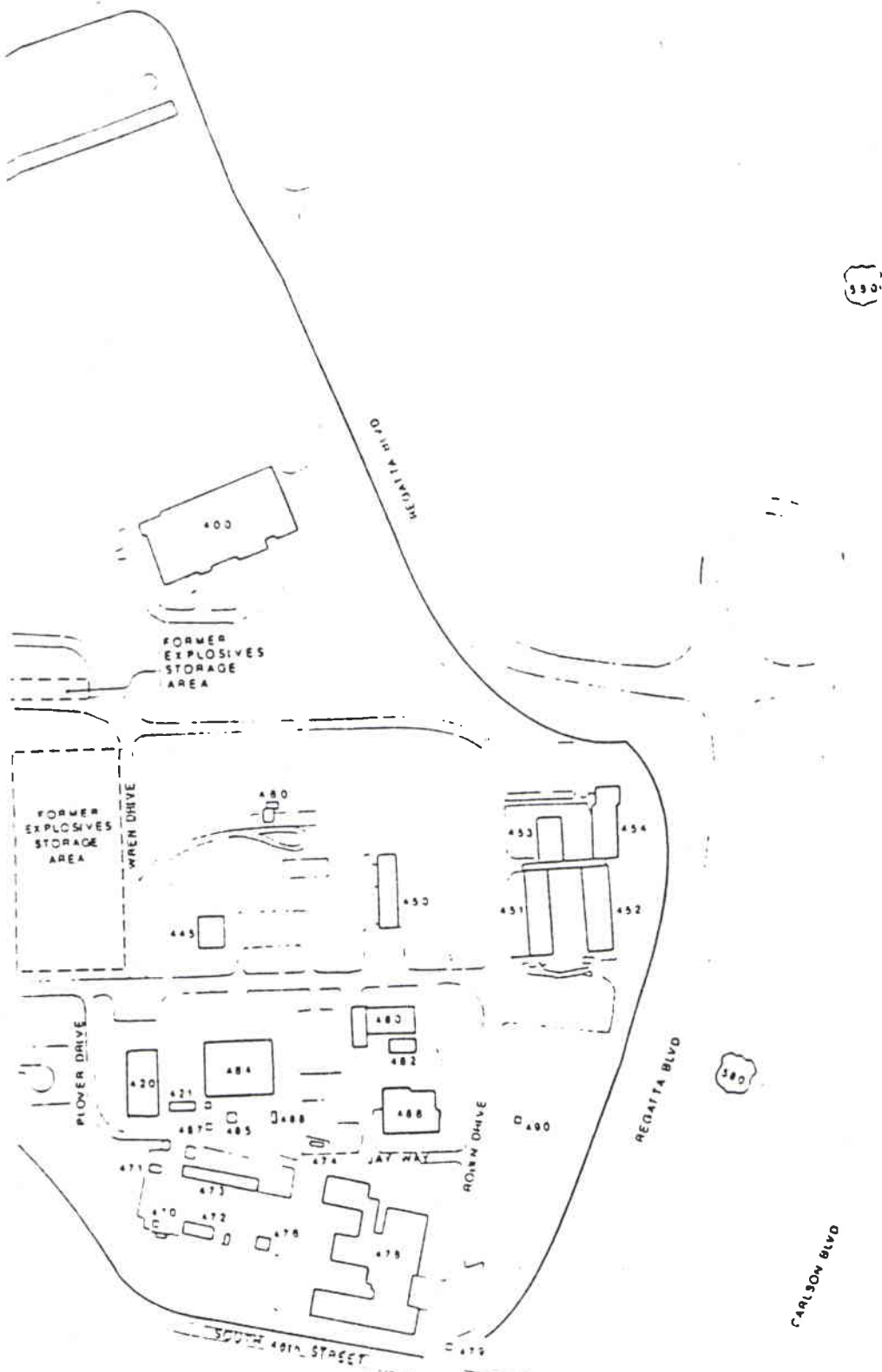
		Result (ug/kg)	Report Limit (ug/kg)
GASOLINE	3810	NO	2.5
STODDARD	3810	NO	2.5
PAINT THINNER	3810	NO	2.5
DIESEL	Extract 3510 - FID, direct inject	NO	1
KEROSENE	Extract 3510 - FID, direct inject	NO	1
MOTOR OIL	Extract 3510 - FID, direct inject	NO	12

DATE RECEIVED: July 5, 1988

DATE STARTED: July 11, 1988

DATE COMPLETED: July 12, 1988

BY: *Paul R. Chaman*



NOT TO SCALE



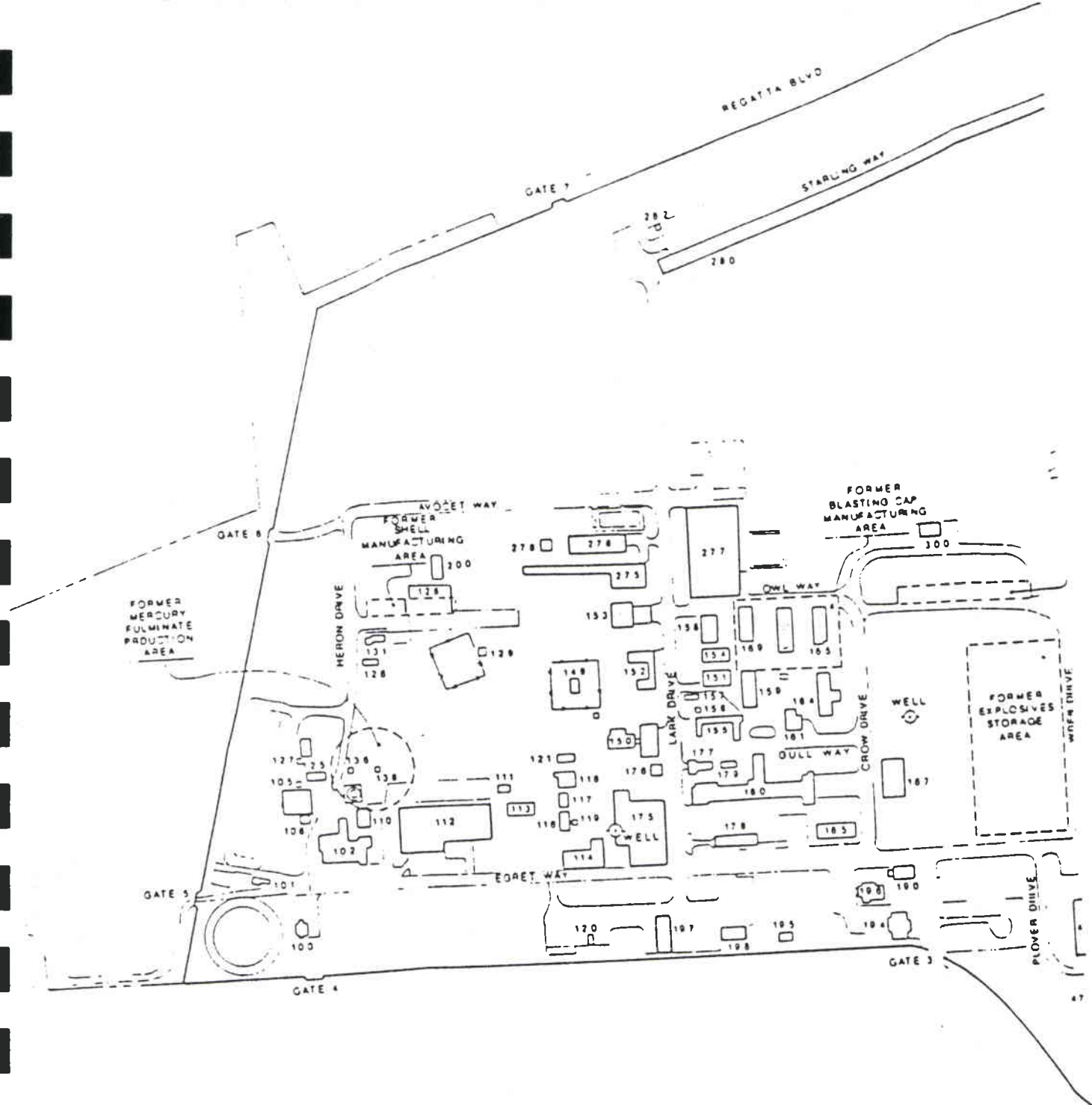
SITE LOCATION MAP

UNIVERSITY OF CALIFORNIA - RICHMOND FIELD STATION

47th STREET AND HOFFMAN BOULEVARD

RICHMOND, CALIFORNIA

DESIGNED BY	APPROVED BY
DATE	DATE
JOHN P.	DRAMIN BY
9313	SLS
DATE	DATE
11-13-77	11-13-77



REV	DESCRIPTION	DATE	BY	APPRO

ONCO
ENVIRONMENTAL
SERVICES, INC.

July 7, 1989

TO: Larry Bell

FROM: Bill Dost
Head, WBRC

SUBJECT: Possible Soil Contamination Related to Wood Preservation Studies

The main wood preservation research facility at the Laboratory was constructed about 1965, to conduct studies related to the preservative treatment of wood with pentachlorophenol in liquified petroleum gas plus co-solvent. These studies continued for 5 or 6 years. The facility was then converted to a conventional treating process. During the conversion, the LPG with its dissolved pentachlorophenol, was discharged through a vent pipe located at the rear of the cylinder. Thus, there was a significant release of pentachlorophenol which may be present in the soil in this area.

Following the conversion, most studies with the equipment have related to either chrome copper arsenate or ammoniacal copper arsenate preservatives. With these, there has been certain amount of leakage, drippage, and spillage onto the concrete and asphalt adjacent to the cylinder. Practice was to hose this area clean, with the water flowing both toward rear of the cylinder onto the earth in the adjacent area, and also to the front of the cylinder, eventually flowing through the trench to the rear of the property and discharging into the grassy swell there. In addition to this spillage and leakage, ammoniated water which was used to surface rinse freshly treated lumber treated ammoniacal copper arsenate, was also discharged, primarily to the trench and thence to the grassy swell. Thus, both the earth in the area behind the cylinder and the earth in the grassy swell may have been contaminated with limited amounts of chromium, copper, and arsenic.

2/WAD:ah

cc: Frank Beall



Engineers
Planners
Economists
Scientists

June 16, 1988

Mr. Glaud Kuykendall
University of California
Richmond Field Station
1301 South 46th Street
Richmond, California 94804

Dear Glaud,

Enclosed are three copies of a technical memorandum describing recommended additional environmental investigations which could be undertaken at the Richmond Field Station (RFS). As noted in the memorandum, neither The California Department of Health Services nor The Regional Water Quality Control Board are currently requiring further study at the RFS. The suggestions for sampling contained in this memorandum would constitute a proactive effort by the RFS to identify potential environmental concerns.

The first three sections of the memorandum summarize information about the environmental setting and history of the RFS. This information was, for the most part, obtained from RFS files. This information is included to explain the basis for the recommended sampling program, which is described in Section 4. Also enclosed are your files which you lent us to use in preparing this memorandum.

If you have any questions or comments about the enclosed technical memorandum, please do not hesitate to call me.

Sincerely,

A handwritten signature in dark ink, appearing to read 'Liz Dodge', with a horizontal line extending to the right.

Liz Dodge
Project Manager

cc: Jill Shapiro, CH2M HILL
Phil Kohne, CH2M HILL

TECHNICAL MEMORANDUM

TO: Glaud Kuykendall
 U.C. Berkeley Richmond Field Station

FROM: Phil Kohne/CH2M HILL Construction Management
 Department
 Liz Dodge/Solid and Hazardous Waste Department
 Jill Shapiro/Industrial and Environmental Services
 Division

DATE: June 16, 1988

RE: Recommendations for Additional Environmental
 Sampling at the University of California Berkeley,
 Richmond Field Station

PROJECT: SFO26372.EA.02

1.0 INTRODUCTION

This memorandum describes environmental investigations which could be conducted at the U.C. Berkeley Richmond Field Station (RFS) to supplement existing data on the potential presence of hazardous materials remaining on the property due to past activities. The purposes of an additional sampling effort would be to:

1. follow up on previous sampling activities to supplement and/or clarify analytical results, and
2. investigate the western portion of the property to evaluate potential soils contamination and assess any possible limitations posed for the first phase of the planned redevelopment.

It should be noted that neither the California Department of Health Services nor the California Regional Water Quality Control Board have requested that additional investigations be conducted at the RFS. The program described herein would be a good faith effort on the part of the University of California RFS to address potential hazardous substance concerns in a proactive manner.

The sampling program outlined in this technical memorandum was developed using existing information supplied by the RFS. Its primary focus is to investigate whether residual contamination may remain from explosives manufacturing operations which previously took place on the property. The

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plan does not address potential environmental impacts of current activities at the RFS.

The following Sections 2 and 3 provide summaries of the RFS environmental setting, history, and results from previous environmental sampling events. These provide the bases upon which sampling recommendations, described in Section 4, are made.

2.0 ENVIRONMENTAL SETTING

SURFACE WATER

The Richmond Field Station is a 150-acre property located adjacent to the Richmond Inner Harbor of the San Francisco Bay. The southern portion of the property comprises 50 acres of marsh, which drain south into the Bay through a single opening in a raised causeway for the Santa Fe Railroad (Kuykendall, RFS files).

Surface water runoff from the 100 acres of the property north of the marsh is directed into two storm drains, at the southeast and southwest ends of the property, which empty into the marsh. Two sloughs also drain into the marsh, along the eastern portion of the property. According to a U.C. Berkeley report, these sloughs serve only dischargers from the City of Richmond and nearby industries (Thomas, RFS file report). Water from the sloughs and drains mixes in the marsh.

REGIONAL GEOLOGY

This section presents a brief description of the regional geology in the vicinity of the Cities of Richmond and El Cerrito. The University of Berkeley Richmond Field Station is located south of Richmond and west of El Cerrito on a gently sloping alluvial plain that is separated from the Berkeley Hills by the Hayward Fault Zone (Jennings and Burnett, 1961). The basin into which the alluvial fan slopes trends from northwest to southeast and is marked on the surface by San Pablo and San Francisco Bays.

The Quaternary alluvial plain deposits are composed of clay, silt, sand, and gravel; and nearshore Bay Mud deposits comprising organic-rich clay and silty clay. These deposits

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range in thickness from 0 to 300 feet, and are underlain by bedrock of the Mesozoic Franciscan Formation. The Franciscan Formation is composed of a complex assemblage of serpentinite, greenstone, graywacke, chert, shale, sandstone, and schist, and outcrops along the western ridge of the Berkeley Hills.

LOCAL GEOLOGY

Subsurface geologic information for the first 100 feet below ground surface at the Richmond Field Station is available from boring logs for 2 wells installed on the property. The logs indicate that approximately 8 feet of clay directly underlie the RFS. Beneath the clay are layers of poorly sorted gravel, sand, and clay which extend to a depth of approximately 40 feet below ground surface. Clay to gravelly clay occurs from approximately 40 to 90 feet below ground surface. Pea gravel was encountered from approximately 90 feet to the bottom of the borings (approximately 102 feet below ground surface).

Four borings to depths of 60 feet below ground surface were drilled at the ICI Americas property, which is located adjacent to the eastern boundary of the Richmond Field Station. The logs from these borings were not available, but the local subsurface conditions were described as predominantly fine-grained sands, silts, and clays with minor amounts of gravel found in poorly graded deposits of sands, silts, and clays (Hall, 1988). The deposits do not appear to be laterally or vertically extensive within the upper 60 feet.

HYDROGEOLOGY

The RFS lies within the Alameda Bay Plain (ABP) groundwater basin (DWR, 1980). This basin extends southward from Richmond to Alvarado, between the Berkeley Hills and the San Francisco Bay. The basin's hydrogeologic conditions are not well characterized because groundwater is not used for municipal supply or for irrigation due to the low permeability and limited thickness of the deposits.

Most groundwater recharge to the ABP groundwater basin in the Richmond area is thought to occur along Wildcat and San Pablo stream beds, located north of Richmond and along the Berkeley Hills located approximately 1½ miles to the northeast. Recharge by rainfall infiltration is believed to be

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limited by shallow low permeability clays and by the large amount of paved areas (Caltrans, 1978). Groundwater discharge is primarily to San Francisco Bay. Groundwater is first encountered at depths from one to ten feet below ground surface (Hall, 1988). Locally, groundwater generally occurs under confined to semiconfined conditions within discontinuous, thin lenses of sand and gravel (Caltrans, 1978). Geologic logs from the U.C. Richmond Field Station indicate that groundwater occurs under confined conditions in a 4-foot-thick permeable gravel zone at a depth of 90 feet below ground surface. Perched groundwater is often encountered in sand and gravel layers above beds of low permeability clay.

Groundwater in the vicinity of the RFS generally flows from north-northeast to southwest toward the Richmond Inner Harbor (Hall, 1988). A cone of depression has been created by a groundwater intercept system currently operating at the adjacent ICI Americas site. The center of this cone is located approximately 1,000 feet southeast of the U.C. Richmond Field Station, but its area of influence does not appear to extend to the RFS (Hall, 1988).

Several aquifer tests have been performed on the 90' deep wells on the RFS property. These tests were performed by U.C. Sanitary Engineering Research Laboratory in 1954. The average transmissibility was calculated from these tests to be 5,775 gal/day/ft. For the average depth of the aquifer, 3.5 feet, the estimated hydraulic conductivity of the 90 foot zone is 1,760 gal/day/ft-squared (235 ft/day). These values fall into the range for clean sand (Freeze and Cherry, 1979), and may be high for the overall sequence of mostly fine-grained deposits beneath the site.

At the ICI Americas property located adjacent to the RFS, slug tests were conducted in monitoring wells for a hydrogeologic investigation (Hall, 1988) to estimate the hydraulic conductivity of shallow permeable zones above 60 feet below ground surface. The well completion details of the wells were not available for review. The calculated hydraulic conductivity values ranged between 0.05 to 2.3 ft/day, and are within the expected range of values for fine sand, silt, and clay (Freeze and Cherry, 1979) which occur in the shallow deposits beneath the site.

The horizontal hydraulic gradient of the shallow groundwater at the ICI America property is approximately 0.004 feet/foot

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Constituent	(mg/l) Range in Concentration	EPA Drinking Water Standard
Arsenic	0.005 - 0.088	0.05
Iron	0.07 - 840	0.30*
Zinc	0.06 - 75	5.00*
Copper	<0.02 - 38	1.00*
Cadmium	<0.02 - 0.15	0.01
Lead	all <0.06	0.05
Aluminum	<0.3 - 44	-

*Secondary standard to provide acceptable aesthetic and taste characteristics

Analytical data for organic compounds cannot be assessed as reported in Hall, 1988, due to the reported high detection limits and unclear units (ppm vs. ppb) in the report.

WATER USES

A survey of wells within an approximate 3-mile radius of the RFS was conducted by DHS (DHS, 1987) during a study for a site located approximately 4,500 feet northwest of the RFS. The California Department of Water Resources (DWR) had records of only five wells within this survey area. A door-to-door canvass was conducted by Caltrans (Caltrans, 1978) and this canvass located over 100 wells in the area of South Richmond, extending approximately 1 mile north of the RFS.

LAND USE

In areas adjacent to the RFS, land uses are primarily industrial. A Safeway truck depot lies to the north, United Grocers Price Club and Bio Rad Labs to the east, and ICI Americas to the west. The ICI Americas property was owned by Stauffer Chemical Company until 1987. The Regional Water Quality Control Board has requested that ICI Americas perform a hydrogeologic investigation near a closed cinder landfill and associated ponds; a preliminary investigation was completed in December 1987. Under a remedial action program designed and implemented by Stauffer, shallow groundwater contaminated with pesticides is currently being extracted and treated. The Richmond Inner Harbor area has recently come under scrutiny by the U.S. Environmental Protection Agency (EPA), the California DHS and the Regional

Water Quality Control Board (RWQCB), due to high contaminant levels found in water and biota of the harbor. At present, the RWQCB has identified 24 properties along the harbor shoreline for hazardous materials investigations.

3.0 PROPERTY HISTORY

Beginning in the 1840s, several operating explosives manufacturing companies were located on the eastern portion of the RFS property. The western portion of the RFS is reported to have been developed for residential use. The California Cap Company (CCC) bought land from the Hercules Powder Company near the beginning of the 20th century. By 1920 CCC had purchased all of the other explosives companies in the area, thereby becoming the only explosives manufacturer on the property.

CCC ceased operations at the end of World War II in 1945, and the University of California purchased the property in 1950. Under the terms of the sale, the California Cap Company was required to remove all hazardous materials before the University would accept the title. The company reportedly complied with this requirement, but the exact nature of the removal activities is not known.

The property is currently owned and operated by the University of California as its Engineering Field Station. Some research projects do involve the use of hazardous materials, which are stored and disposed in accordance with the same requirements as the main campus (Kuykendall).

UC plans to create a Research Campus, for both private and public users at the Richmond Field Station. Land uses in the Concept Plan include large research facilities, a regional library, recreational open space, and private sector development in the eastern portion of the property. Shoreline alterations are not proposed.

PREVIOUS SAMPLING ACTIVITIES

Because one of the California Cap Company's primary activities was the manufacture of the explosive fulminate of mercury, the Richmond Field Station was included on DHS's list of abandoned hazardous waste sites in 1981. The Department of Fish and Game, the San Pablo Sanitary District, and Cal

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OSHA agreed that fulminate of mercury might be present on the property, which presented the risk of explosion and soil contamination. DHS began an investigation of the RFS property in 1981.

Three rounds of sampling were conducted between 1981 and 1984, as summarized below. Sampling locations are indicated on Figure 1.

In 1981, soil samples were taken from five locations, although the exact types of analyses performed are not known. Available data show that elevated concentrations of mercury were found in two of these samples: Sample 2, near the former shell manufacturing area, contained 105 parts per million (ppm) of mercury, and Sample 6, taken from the marsh, contained 23 ppm of mercury. A DHS report (DHS, June 24, 1982) indicated that arsenic, copper, zinc, and lead were also present in the RFS soil samples, in unspecified concentrations.

In 1982, DHS collected 17 soil samples from the RFS and analyzed them for 29 inorganic constituents. Sampling locations are shown on Figure 1. Mercury was not detected in any of the samples (Table 1). None of the inorganic constituents analyzed for concentrations exceeded Total Threshold Limit Concentrations (TTLC) set by DHS to identify a material as hazardous. At least two samples were analyzed for DDT; none was detected. DHS concluded that no mercury remained on the RFS property and recommended that it be removed from the list of abandoned hazardous waste sites. It should be noted that although none of the 1982 DHS samples exceeded the TTLC, several showed comparatively high metals concentrations. These include:

- o Sample SSL 001B, collected near the northeast corner of the former explosives storage area near Egret Way which had 485 ppm of manganese and 349 ppm of copper.
- o Sample SSL 005B, collected from the former explosives storage area west of Owl Way, which contained 908 ppm of manganese.

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- o Sample SSL 007B, collected between Buildings 163 and 162, which contained 135 ppm of chromium, 975 ppm of lead, 452 ppm of copper, and 473 ppm of zinc.
- o Sample SSL 009A and SSL/010A, collected in the former mercury fulminate production area, which contained 359 ppm and 577 ppm of copper, respectively.
- o Samples SSL 11A and SSL 11C, collected near the southeast corner of the facility which contained 84 ppm and 283 ppm of arsenic, respectively. These samples also contained 471 ppm and 910 ppm of zinc, respectively.

These data indicate that the presence of metal contamination varies widely throughout the facility. For example, although elevated manganese levels were found in two samples (SSL001B and SSL005B) in the former explosives storage areas, other samples collected in the same areas (SSL001C and SSL005C) showed much lower concentrations. It appears likely that there may be small, widely scattered areas with elevated metals concentrations in several locations on the property.

DHS submitted the results of their sampling to the Regional Water Quality Control Board who, in turn, expressed concern about potential mercury contamination of the underlying aquifer(s) and of surface waters discharging to San Francisco Bay. In 1984, U.C. Berkeley retained the EAL Corporation to analyze water samples from two existing wells and four surface water samples collected in the slough and marsh areas. The wells had been drilled previously for a research project and are completed approximately 90 feet below the ground surface. Results are summarized in Table 2 below:

TABLE 2 RESULTS OF EXISTING RFS WELL SAMPLE ANALYSES
(EAL CORPORATION, 1984)

	Sample 5 Well 167 (ppm)	Sample 6 Well 175 (ppm)	Safe Drinking Water Act Maximum Contaminant Level MG?! (ppm)
Copper	0.01	<0.006	1.0 ^a
Iron	0.04	<0.02	.3 ^a
Lead	0.03	0.04	.05
Mercury	<0.0005	<0.0005	.002
Zinc	.083	0.067	5.0 ^a

^aSecondary drinking water standard (affects taste, not health)

Results of analysis of samples from the east and west storm drains and in the sloughs are summarized in Table 3:

TABLE 3 RESULTS OF SLOUGH AND STORM DRAIN SAMPLE ANALYSES
(EAL CORPORATION, 1984)

	Sloughs (ppm)		RFS Storm Drains (ppm)		STLC mg/l	Surface Water ^a Quality Objectives (ppm)
	South Sample 3	North Sample 1	East Sample 4	West Sample 2		
Copper	0.11	0.086	0.024	0.01	2 _c	.0029 ^b _c
Iron	2.4	0.55	0.11	0.54	5	.0056
Lead	0.24	0.14	0.02	0.057	.2	.000025
Mercury	<0.0005	0.0005	0.001	<0.0005	250	.058
Zinc	0.072	1.1	0.56	0.76		

^aSan Francisco Bay RWQCB Plan, 1986 (Same as U.S. EPA Ambient Water Quality Criteria for Marine Life.)

^bRecommended EPA criterion, but background levels in San Francisco Bay are .001 to .004 mg/l.

^cNo standard available.

As shown in table 3, the results of the 1984 sampling generally indicated that the concentrations of metals were higher in water from the sloughs than in the storm drains that serve the RFS. The only exception to this is the data for zinc which show that concentrations were slightly higher than in the storm drains than the south slough sample.

The data in Table 3 show that water samples from the RFS Wells 167 and 175 satisfy U.S. EPA drinking water criteria for the five metals. Metals concentrations in the surface water samples from the sloughs and storm drains were lower than the state soluble toxic limit concentration (STLC), indicating that it does not meet the criteria for a hazardous waste. However, all samples exceeded the RWQCB's Surface Water Quality Objectives (which are the same as the U.S. EPA's Ambient Water Quality Criteria for marine life). Because the marsh and sloughs have been impacted in the past by discharges from ICI and other Richmond facilities, it is difficult to determine the sources of metals found in water from the sloughs and storm drains.

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The findings of the 1984 surface and groundwater sampling effort were forwarded to the RWQCB. In response to a 1984 RWQCB request for a water quality plan, UC submitted a memorandum concluding that based on the recent sampling results, surface runoff and infiltration from RFS were not adversely affecting groundwater, surface water, or Bay waters (Thomas, RFS file report).

No further agency actions or requests occurred until November 1987, when DHS requested copies of the existing sampling data. UC sent the data and requested that the site be removed from any hazardous site list.

In 1987, DHS conducted another preliminary assessment of the facility, under U.S. Environmental Protection Agency funding. The report concluded that no further EPA action or site investigation was necessary. DHS is continuing to consider the facility as a "medium" priority, until sampling results in areas previously tested can be verified. DHS has indicated concern about the adequacy and quality assurance/quality control on previous DHS testing, particularly the results of mercury testing in 1982 (Adrada, DHS communication). The RWQCB has also expressed concern about contamination from "various metals" (Singer, 1983).

4.0 AREAS FOR FURTHER INVESTIGATION AND RECOMMENDATIONS FOR ADDITIONAL SAMPLING

As discussed in the introduction to this memorandum, the purposes for additional environmental investigation at the RFS include: 1) clarification of previous analytical data, and 2) investigation of the western portion of the property where the first phase of redevelopment is planned. Information on the historical use of the property indicates that contaminants which could be present at the property include:

- o Mercury, from mercury fulminate production
- o Other metals, such as copper, lead, chromium, manganese or zinc from shell manufacturing activities
- o Solvents and lubricating oils, also from shell manufacturing activities

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- o Nitrogen compounds, from explosives manufacturing. (Note: details about all the types of explosives produced by the California Cap Company are not known. Explosives commonly produced by such facilities in the early part of this century include such nitrogen-containing compounds as TNT and nitroglycerin).

To date, investigations at the RFS have been limited to metals and pesticides. Results of past sampling activities indicate that small areas having elevated metals concentrations may be present at the RFD, but no large areas of contamination have been found.

Recommendations for additional sampling of soil and groundwater are discussed below.

SOIL

As shown on Table 4 and Figure 1, eight soil sampling areas are recommended, including five from former California Cap Company production areas, two from the undeveloped western portion of the RFS property, and one from an area considered to represent background conditions. These are recommended to be composite samples, with each sample consisting of soil taken from three locations in the area of interest and mixed in equal proportions. This sampling approach is suggested for the RFS investigation because information about the precise locations of hazardous materials production, disposal, and storage are not well known. Composite sampling permits information from a general area of concern to be investigated more cost-effectively than collection of many single grab samples. Figure 1 shows general recommended sampling locations. The exact locations should be determined in the field by an experienced field sampling team leader.

GROUNDWATER

Table 4 and Figure 1 present the rationale and recommended locations for four shallow groundwater monitoring wells. As explained in Table 4, monitoring wells MW-1, MW-2, and MW-3 would be at the southern end of the property in order to detect contaminants that might be migrating offsite from upgradient areas of the property. MW4 would be located upgradient of areas of known or suspected contamination in order to provide a measure of background conditions. The

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four new wells would be screened in the shallowest water-bearing zone, expected to be 10 to 20 feet below the ground surface. Installation of shallow wells is recommended because spills or discharges to the ground which may have occurred in the past first impact the shallowest groundwater zone. As with soil sampling, the location, depth, and screened intervals of new wells should be determined in the field by a qualified hydrogeologist.

ADDITIONAL INFORMATION

Surface Water

Additional surface water and sediment sampling is not recommended at the RFS because the tidal marsh and the sloughs which feed it have many past and present sources of contamination it would be not be possible to readily differentiate the influences of the RFS from those of ICI, the City of Richmond, and other surrounding dischargers.

Because the sampling recommended in this tech memo is directed at identifying contamination on the portion of the RFS property planned for redevelopment, sampling in the marsh is not included here.

Field Protocols

Field investigations at the RFS should be conducted in accordance with the procedures described in The California Site Decision Tress (DHS, 1985) and A Compendium of Superfund Field Operations Methods (EPA, December 1987) or other equivalent procedures for sample collection, well installation, disposal of fieldwork-generated material, record-keeping, quality control procedures, health and safety considerations, and sample control procedures. Laboratory analyses should be conducted in accordance with the procedures in Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020 (EPA, EPA-600/4-79-020, revised March 1983), Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846 (EPA, W846, September 1986), and Standard Methods for the Examination of Water and Wastewater (American Public Health Association, 16th ed. 1985).

Table 4
(Continued)

Medium	Location (see Fig. 1)	Sample Type (Grab or Composite)	Analytical Parameters	Rationale
Soil	S7	Composite of three surface soil samples from the area south of Park Drive and west of Avocet Way.	Metals (see Table 5) Pesticides	Test for contamination from probable past residential use.
	S8	Composite of three surface soils from northwest portion of property.	Metals (see Table 5) Ammonia Nitrite/Nitrate Total Kjeldahl Nitrogen Pesticides	Establish background criteria.
Groundwater	MW1	Grab sample from new shallow well to be installed downgradient of the former mercury fulminate production area.	Metals (see Table 5) Ammonia Nitrite/Nitrate	Test for residuals from explosives manufacturing.
	MW2	Grab sample from new shallow well to be installed downgradient of the former shell manufacturing area.		Test for potential residuals from manufacturing, e.g., metals, machining oils, lubricants, degreasers, and solvents.
	MW3	Grab sample from new shallow well to be installed downgradient of the western portion of the property.	Metals (see Table 5) Pesticides	Test for potential contamination from probable past residential use.
	MW4	Grab sample from new shallow well to be installed in north western portion of site.	Metals (see Table 5) Pesticides Ammonia Total Kjeldahl Nitrogen Nitrite/Nitrate	Establish upgradient conditions.

Table 5 RECOMMENDED ANALYTICAL PROCEDURES

<u>Metals</u>	<u>EPA Method</u>	
	<u>Water</u>	<u>Soil</u>
Arsenic	206.3	7061
Cadmium	213.1	7130
Chromium (total)	218.1	7190
Copper	220.1	7210
Manganese	243.1	7460
Mercury	245.1	7471
Lead	239.1	7420
Zinc	289.1	7950
<u>Volatile Organic Compounds</u>	624	8240
<u>Extractable Organic Compounds</u>	625	8270
<u>Pesticides</u>	608	8080
<u>Nitrogen Compounds</u>		
Ammonia	350.2	350.2
TKN	351.3	351.3
Nitrite/Nitrate	353.3	353.3

1982 DHS Soil Sampling Results

[illegible]

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SOURCES OF INFORMATION

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Thomas, J.F., Ph.D, PE, Chairman Sanitary Environmental, Coastal Hydraulic Division, Department of Civil Engineering, University of California, Memorandum, September 18, 1984.

Department of Health Services, Hazardous Waste Surveillance and Compliance Report, July 15, 1982.

Adrad, Bernie, Project Officer, Department of Health Services, Personal Communication, June 1988.

CH2M HILL, Draft Workplan for the Phase I Remedial Investigation Feasibility Study, Summer Del Caribe, Richmond, California. Prepared for the California Department of Health Services, November 1987.

Singer, Harold J. RWQCB Toxics Division Chief, letter dated March 10, 1983 to Frank Genta, Office Facilities Manager RFS.

SFR160/015

jn/SFR161/01



Engineers
Planners
Economists
Scientists

December 6, 1988

SFO26372.EA.02

Mr. Glaud Kuykendall
University of California
Richmond Field Station
1301 South 46th Street
Richmond, California 94804

Subject: Technical Memorandum Summarizing Results of
Environmental Sampling at the University of
California Richmond Field Station

Dear Glaud,

Attached is the Technical Memorandum summarizing the results of the field investigations conducted at the University of California, Richmond Field Station between October 18, and November 2, 1988. Included in this memorandum is a description of the site investigation, the sampling site locations, and the laboratory analyses and results.

To briefly summarize the results of the soil sampling; mercury was detected in the vicinity of the old mercury fulminate facility at levels significantly higher than the Total Threshold Limit Concentration (TTL) specified by California Administrative Code Title 22, Section 66699. Elevated concentrations of zinc and copper were also found at this same location.

In the undeveloped portion of the Richmond Field Station, concentrations of metals (As, Cr, Mn, Hg, Pb, Zn, and Cu) were significantly lower than the TTLs for these metals. Pesticide concentrations were below the detection limits.

If you have any questions or comments about the enclosed technical memorandum, please call me.

Sincerely,

Alexander Coate
Environmental Engineer

cc: Liz Dodge, CH2M HILL
Phil Kohne, CH2M HILL
Jill Shapiro, CH2M HILL

Attachment

I. SITE RECONNAISSANCE

A one day reconnaissance of the Richmond Field Station property was conducted on October 18, 1988. The entire RFS property was visually inspected. Emphasis was placed on the western undeveloped area and the prior mercury fulminate site. During this site inspection target areas in the western undeveloped area were identified for sampling. The following is a discussion of observations made during the site visit.

In the southeast corner of the property, south of the Oswald Pond, a barren area devoid of vegetation exists. The denuded area which is easily distinguishable from the surrounding area by the red soils found there, covers an area approximately 30 yards by 40 yards. Some water is visible in this area and is likely to be bay water from the last high tide. Access to this area is prevented by a locked gate (Gate 5).

Larry Bell, the RFS Project Coordinator, provided a possible explanation for the presence of these red soils. The red soils are thought to be the remains of slag piles deposited by Stauffer Chemical at some time in the past. These soils were used as fill throughout the RFS property, resulting in sporadic appearance of red soils during subsequent investigations and sampling.

Analysis of the composition of soils in the vicinity of the devegetated area in the south east corner of the property was conducted by the California Department of Health Services (DHS) in 1981 and 1982. Significant concentrations of zinc (910 ppm) were found in these samples. However, the concentrations were lower than the 5,000 ppm TTLC for zinc.

Reddish soils and minimal vegetation were noted at other locations on the RFS property. The most obvious location is the northeast corner of the intersection of Owl Way and Crow Drive. Reddish soils were also noted in a sparsely vegetated grassy area west of Building 136. This area is of a slightly lower elevation than adjacent areas. Historically, this is the site of a mercury fulminate production facility that was operated when the property was owned by the California Cap Company.

Mercury was recently seen in a trench dug by an RFS employee on the north side of building 125. The area is said to have been excavated to remove any contaminated soils prior to purchase by U.C. Berkeley. The salt grasses that vegetate this area are somewhat reddish in color. However, the distressed condition of these grasses may be attributable to the dry summer weather.

The site where the Blasting Cap Manufacturing Area existed is now occupied by Buildings 163, 165, and 168. The ground between these buildings has been landscaped with lawn grass. Despite the imported topsoil and the application of chemical fertilizers, there are noticeable areas where these grasses are not growing.

In the southwest portion of the property, there is evidence of recent topsoil removal/scraping over a large area west of Avocet Way and South of Lark Drive. South of this scrapped area, piles of soil and vegetation debris were seen. Sampling sites in this area were selected in zones that did not show evidence of recent disturbance. This southwestern area was subdivided into two areas for sample collection purposes.

II. SAMPLE SITE SELECTION

Table 1 presents a description of the samples collected. The location of each sampling site is shown on Figure 1.

The vicinity of the now removed mercury fulminate facility was selected for sample collection. The samples at this location were designated as S1-1, S1-2, and S1-3.

Three samples were collected to describe the southern most area near the mulching piles. These three samples were composited for laboratory analysis and designated as S2-1, S2-2, and S2-3. Another three samples were collected from the area just south of Lark Drive that is thought to have been the location of residential homes during the 1930s. These three samples were also composited for analysis and labeled S3-1, S3-2, and S3-3.

The undeveloped area west of the Fog Tunnel Building and east of Regatta Way was described with another three samples. These three collected for compositing were S4-1, S4-2, and S4-3.

The property north of Lark Drive and east of the Fog Tunnel Building was subdivided into two portions. The southern portion, where previous residential homes are thought to have existed, was described with samples S5-1, S5-2, and S5-3. The center of this area is currently the site of plant growth experiments. Electrical conductivity experiments are also being conducted in this area. Samples were collected around the perimeter of these experiments in order not to disturb them.

An additional three samples were collected from the northern portion of the undeveloped property. In this area the topsoil and vegetation have been recently removed from a large area. The samples were collected from still vegetated areas that had not been scraped. The samples collected in this area were S6-1, S6-2, and S6-3. Sample S6-3 was collected in the eucalyptus grove east of Building 400.

III. SAMPLE COLLECTION

Test pits approximately two feet in depth were excavated in the sampling areas described above. These sampling site locations are shown on Figure 1. The pits were excavated using a backhoe owned and operated by U.C. Berkeley. The operator dug the pit, and

samples were collected from the wall of the pit by a CH2M HILL representative. A composite of soils to a depth of two feet was collected from each pit. After sample collection, the pit was refilled with the excavated soils. Prior to sample collection, the air in the pit was tested for the presence of volatile organics using an HNu. The HNu was calibrated on the day that samples were collected. No HNu measurements above zero were made during the sampling.

Samples were placed in a 500ml wide mouth amber glass bottle and put on ice. Samples were sent to the laboratory for analysis on the same day as they were collected.

IV. LABORATORY ANALYSIS

Upon receipt by the laboratory, the samples collected at each location were thoroughly mixed. Equal portions by weight of the three samples representing a given section of the RFS property were composited. Unmixed samples were set aside for future analysis if necessary. All of the six composited samples were analysed for the following metals using the EPA method shown in parenthesis:

arsenic	(7061)
chromium	(7190)
copper	(7210)
manganese	(7460)
mercury	(7471)
lead	(7420)
zinc	(7950).

All of the six composited samples, except S1 collected in the vicinity of the old mercury fulminate processing facility, were analysed for pesticides and PCBs using EPA method 8080.

V. RESULTS

A copy of the laboratory results are attached. The laboratory analysis of the samples collected in the vicinity of the mercury fulminate facility revealed the presence of mercury at levels significantly higher than the Total Threshold Limit Concentration (TTLC) specified by California Administrative Code Title 22, Section 66699. The wet-weight TTLC for mercury and/or mercury compounds is 20 mg/kg. An average mercury concentration of 260 mg/kg was observed in the samples collected. To ensure the accuracy of the high mercury measurements at sampling site S1, the analysis was done three times using three different portions of the composite.

In addition to mercury, elevated concentrations of zinc and copper relative to the samples collected at other locations on the U.C. Berkeley property were found in the vicinity of the old mercury fulminate facility. However, these copper and zinc levels are well below the TTLC for these metals.

The laboratory analysis of samples collected on the undeveloped portion of the RFS property revealed the concentrations of the

TABLE 1

<u>Sample</u>	<u>Description and Location</u>
S1-1	<p>-Composite of soils to a depth of 2 feet. Soils disturbed to a depth of 1.5 feet. Undisturbed ban clays to 2 feet. HNu reading of zero.</p> <p>-Located on north side of building 125 on the south side of Heron Drive, west of ramp.</p>
S1-2	<p>-Composite of soils to a depth of 2 feet. Soils show brown disturbed sediments for first 1.5 feet. At 2 feet, mostly mottled brown clays. HNu reading of zero.</p> <p>-Located on north side of building 125, south of Heron Drive, east of ramp.</p>
S1-3	<p>-Composite of soils to a depth of 2 feet. Surface soils mostly imported gravels below which reddish soils similar to those in the vicinity of Stauffer Chemical were found. Red soils found in a band 8 inches thick at a depth of 8 inches. Disturbed clays found at 2 feet. HNu reading of zero.</p> <p>-Located on west side of building 136, north of Heron Drive.</p>
S2-1	<p>-Composite of soils to a depth of 2 feet. Hard brown silty clays. HNu reading of zero.</p> <p>-Located 48 feet north and 191 feet west of the NW corner of Heron Dr. and Avocet Way.</p>
S2-2	<p>-Composite of soils to a depth of 2 feet. Hard brown silty clays. HNu reading of zero.</p> <p>-Located 48 feet north and 191 feet west of the SW corner of RFS property.</p>
S2-3	<p>-Composite of soils to a depth of 2 feet. Disturbed top soils first 6 inches. Eight inch band of reddish soils similar to those in the vicinity of Stauffer chemical found at a depth of 6 inches. These red soils found at one end of 6 foot trench only. HNu reading of zero.</p> <p>-Located in historic mulching grounds 48 feet west of Avocet Way and 120 feet from the SW corner of Avocet and Heron Drive.</p>
S3-1	<p>-Composite of soils to a depth of 2 feet. Hard dy silty clays. HNu reading of zero.</p> <p>-Located 60 feet south of Lark Drive and 60 feet west of Avocet Way.</p>

Sample

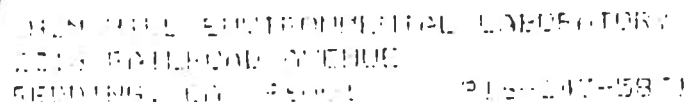
Description and Location

- S3-2 -Composite of first 2 feet of soils. Disturbed silty clays to a depth of one foot, clay to a depth of two feet. HNu reading of zero.
-Located 150 feet south of wind tunnel parking lot, 135 feet east of RFS property fence.
- S3-3 -Composite of first 2 feet of soils. Soils brown (similar to those found at S3-2), silty clays. HNu reading of zero.
-Located 169 feet east of fog tunnel parking lot, 260 feet south of Lark Drive. HNu reading of zero.
- S4-1 -Composite of first 2 feet of soils. Soils brown dry silty clays with a few gravels up to 1 inch in diameter. HNu reading of zero.
-Located 730 feet south of the northern edge of the RFS property, 62 feet east of fence along Regatta Blvd.
- S4-2 -Composite of first 2 feet of soils. Soils brown dry silty clays with some gravels from the surface to a depth of 1.5 feet. Some gravel size pieces 6 cement found. Clays below this to a depth of 2 feet. HNu reading of zero.
-Located 430 feet south of the northern edge of RFS property, 62 feet east of fence along Regatta Blvd.
- S4-3 -Composite of first 2 feet of soils. Some gravels in silty clays blending to clays at a depth of 2 feet. Some cement pieces found up to 3 inches in diameter. A band of white material (cement powder ?) 1 inch thick found at a depth of 8 inches. HNu reading of zero.
-Located 190 feet south of northern boundary of the RFS property, 62 feet east of the fence along Regatta Blvd.
- S5-1 -Composite of soils to a depth of 2 feet. Dry silty clays merging to brown hard clays at 2 feet. HNu reading of zero.
-Located 100 feet east of fog tunnel, 250 feet north of Lark Drive.

Sample

Description and Location

- S5-2 -Composite of soils to a depth of 2 feet. Significant amount of cement pieces (50%) approximately 1 inch thick. Appears to be an old cement slab. Associated with this is white ashy/sandy material (fireplace residue?). Clay at depth of 2 feet. HNu reading of zero.
-Located 251 feet north of parking west of building 277, 318 feet west of building 165.
- S5-3 -Composite of soils to a depth of 2 feet. Brown dry silty clay to a depth of 2 feet. HNu reading of zero.
-Located 100 feet west of building 165 and 100 ~~feet~~ north of pond adjacent to building 277.
- S6-1 -Composite of soils to a depth of 2 feet. Soils composed of wetter clays at a depth of 1.5 feet. Disturbed vegetated surface top soil to a depth of 1.5 feet. HNu reading of zero.
-Located 180 feet east of the fog tunnel, 276 feet south of the northern border of the RFS property.
- S6-2 -Composite of soils to a depth of 2 feet. Dark clayey soils from just beneath the first foot of vegetated top soil. HNu reading of zero.
-Located 270 feet south of northern boundary of the RFS property, 221 feet west of building 400.
- S6-3 -Composite of soils to a depth of 2 feet. Dry top soil composed of mottled clayey fill to a depth of 2 feet. HNu reading of zero.
-Located in eucalyptus trees east of building 400, 35 feet west of road, 165 feet north of bend in road.



LOCATION: ALEX. COOTE
SAMPLE DESCRIPTION: SOIL
DATE OF SAMPLE: 11-1-92

DATE RECEIVED: 11-5-82

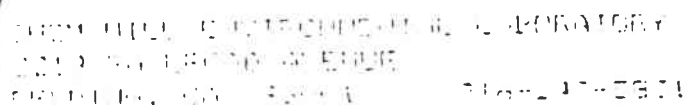
ANALYST	DATE	CHROMIUM mg/L	TOTAL CHROMIUM mg/L	MANGANESE mg/L	MERCURY mg/L	LEAD mg/L	ZINC mg/L	COFFEE mg/L
SAFETY	11-21							
COMPOSITE								
01-COMPOSITE	1.2	74.6	482	2604	76.1	476	327	
02-COMPOSITE	1.7	70.8	575	0.87	19	100	47.5	
03-COMPOSITE	0.4	62.1	554	0.14	16	24.5	16	
04-COMPOSITE	0.5	44.7	743	0.19	19	30.9	15	
05-COMPOSITE	0.6	48.0	819	0.18	38.1	40.5	24.1	
06-COMPOSITE	2.3	29.3	672	0.07	7.7	19	15	
DETECTION LIMIT	0.4	0.6	0.2	0.06	3.6	0.2	0.6	
TEST METHOD	6010	6010	6010	7471	6010	6010	6010	
DATE ANALYZED	11-21	11-21	11-21	11-23	11-21	11-21	11-21	
FILE STANDARD	500	2500	N.S.	20	1000	5000	2500	

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FRB

— *Les Églises protestantes* —

L. L. Jacoby



REFERENCE NUMBER: 2146
PAGE 2 OF 3
DATE: 11-2-93
PHONE:

SAMPLED BY: ALEX COATE
DATE RECEIVED: 11-2-98
DATE ANALYZED: 11-29-98

REF: TEL# 800.405.1065

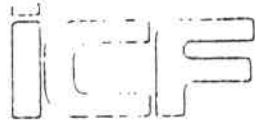
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Amount of ... per ...

It is important to note that the above information is for informational purposes only and should not be used for any other purpose. The information is provided as a service to the public and is not intended to be used for any other purpose.

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Bennett & T. Gray.



RECOMMENDATIONS FOR FURTHER ACTION

DATE: May 15, 1987

PREPARED BY: Rick Dreessen, ICF Technology Inc.

SITE: University of California,
Richmond Field Station
47th Street and Hoffman Boulevard
Richmond, CA 94804
Contra Costa County

TDD #: F9-8701-71

EPA ID #: CAD980673628

1. Initial FIT Conclusions and Recommendations for Further Action:

a) Site Description:

The 113-acre University of California (UC), Richmond Field Station (RFS), located adjacent to San Francisco Bay in the commercial land-use area of Richmond (Exhibit 1, Site Location Map), was owned by the California Cap Company (Cal Cap) until 1950. In 1849 Cal Cap purchased the land on this site from the Hercules Powder Company and began production of dynamite for gold mining. During the Civil War, Cal Cap changed to ammunition production (caps and bullets) which they produced through World War II. One of the products used on-site was fulminate of mercury, a highly explosive material (1).

The RFS was purchased from Cal Cap by the UC in 1950. The present site encompasses biological study areas, agricultural fields, and a reclaimed marsh area (Exhibit 2, Site Facility Map). There are only a few small wooden structures left from the original plant, most of which have been renovated since 1950. The following are active UC facilities currently located at RFS (2)

- Sanitary Engineering and Environmental Health Research Laboratory
- Water, Thermal, and Chemical Technology Center
- Earthquake Engineering Research Center
- Materials Science and Minerals Engineering Center
- Naval Architecture Center
- Solid Waste Management Center
- Structural and Fire Test Laboratory
- Earthquake Simulator Laboratory
- Hydraulics and Coastal Engineering Center
- Forest Products Laboratory
- Geotechnical Engineering Center
- Northern Regional Library Facility

It is not clear from available file information or conversations with state and local agency personnel what activities and wastes, if any, may currently be associated with each facility.

The RFS is not regulated under the Resource Conservation and Recovery Act (RCRA).

Apparent Problem:

The RFS was purchased from Cal Cap by UC beginning in 1950, with the last parcel purchased in 1963. As part of the sales agreement, Cal Cap was required to clear the site of all hazardous material before the title would be accepted by UC. This requirement was considered to be fulfilled, by Cal Cap removing the fulminate of mercury plant (building 102) from the site (18).

In 1980 staff of the California Department of Fish and Game (CDFG), California Occupational Safety and Health Administration (Cal OSHA), San Pablo Sanitary District, and UC Berkeley became concerned that the site may be contaminated with mercury, which is used in the manufacture of fulminate of mercury, a Cal Cap product (1). Fulminate of mercury, $\text{Hg}(\text{CNO})_2$; highly explosive and soluble in alcohol, ammonium hydroxide, and water, was reportedly used at only one location, Building 102 (Exhibit 2 Site Facility Map) (4). It is not clear from available file information why these agencies became concerned at this particular time.

An investigation of the RFS was initiated in 1981 under the Abandoned Site Project (ASP) by the California Department of Health Services (DOHS), Hazardous Materials Management Section. Twelve soil samples, taken in 1981, were each analyzed for mercury, metals and DDT (Table I). Results indicated levels of mercury (105 ppm), metals (arsenic-190 ppm, copper-506 ppm, zinc-789 ppm, lead-524 ppm) and DDT (1.7 ppm) above DOHS Total Threshold Limit Concentrations (TTLCs). The sample of 1.7 ppm DDT was a soil composite of six separate locations taken in the marsh area (5). This sample also registered the highest level of mercury contamination. In 1982 DOHS collected additional soil samples (17 samples), each analyzed for metals, DDT and DDE, to confirm earlier results (Table I). As part of the 1982 sampling effort one surface soil and one 2-foot core were collected from the marsh. Both of these samples were taken at the same location and were not representative of the entire marsh area. These analyses indicated the following:

- Mercury was not detected in any samples.
- Analyses of marsh samples for DDT and DDE revealed no detectable levels (detection limit of 0.1 ppm).
- Metal concentrations on all samples were below DOHS action levels (arsenic-283 ppm, zinc-910 ppm, copper-577 ppm, lead-975 ppm).

No further soil sampling efforts have been conducted at the UC RFS and available file information indicates that the contradiction in the levels of mercury and DDT between 1981 and 1982 sample analyses has not been resolved.

Based on the results of the 1982 sampling effort, the DOHS concluded that there was no mercury or DDT contamination on-site, and so informed RFS in a letter dated December 17, 1982 (3). The letter stated that the RFS would be removed from the list of California abandoned hazardous waste disposal sites (3).

TABLE I

Collection Date: February 19, 1981 (6 samples)
Method: X-Ray Fluorescence

Constituent	Concentration (ppm)	TTLC (ppm)
Arsenic	6 - 190	500
Barium	143 - 292	10,000
Copper	11 - 506	2,500
Iron	15,200 - 70,000	.
Mercury	0.4 - 105	20
Manganese	not detected - 560	.
Lead	not detected - 524	1,000
Strontium	21 - 85	.
Zinc	35-452	5,000
N - Methyl Carbamates	not detected	.
Organo Phosphate	not detected	.
DDT	1.7	1

*No designated standard.

Collection Date: April 16, 1981 (6 samples)
Method: Flameless AA

Constituent	Concentration (ppm)	TTLC (ppm)
Mercury	3 - 27.4	20

Collection Date: June 28, 1982 (17 samples)
Method: X-Ray Fluorescence

Constituent	Concentration (ppm)	TTLC (ppm)
Arsenic	3.3 - 283	500
Barium	90 - 290	10,000
Copper	0-577	2,500
Iron	11,900 - 27,000	.
Mercury	not detected	20
Manganese	72 - 908	.
Lead	not detected - 135	1,000
Strontium	12 - 41	.
Zinc	20 - 910	5,000
DDE, DDT	not detected	1

*No designated standard.

In spite of the DOHS recommendation, California Regional Water Quality Control Board (RWQCB) personnel were still concerned with the level of metal contamination. At the request of RWQCB, additional sampling of surface runoff and ground water was conducted by UC on March 26, 1984 (6 samples). Analyses indicated that contamination levels fell below Maximum Contaminant Levels (MCLs) as set by RWQCB (Table II). It should be noted that UC did not analyze any of the 1984 samples for DDT.

No sampling activities have taken place since March 1984. The RWQCB presently ranks this site as non-priority because of the apparent absence of mercury and DDT and the lack of groundwater usage as a drinking source (13).

b. HRS Factors:

Observed Release:

Initial soil sampling performed by DOHS on February 19 and April 6, 1981, indicated high levels of mercury, metals, and DDT. As part of the February 19, 1981, sampling effort a composite sediment sample was taken in the marsh area. Part of the marsh area was formerly a Stauffer Chemical landfill and UC suspected that residual DDT might be left from the landfill operations (12). The sample consisted of a sediment composite from six separate locations within the marsh. Analyses showed 1.7 ppm DDT and 105 ppm mercury. Because the number of samples was limited, DOHS performed more extensive sampling on June 28, 1982. As part of the 1982 sampling effort one surface and one 2-foot core were collected from the marsh. Both of these were taken at the same location and were not representative of the entire marsh area. These analyses revealed no detectable levels of mercury or DDT. They did, however, reveal metal contamination below Soluble Threshold Limit Concentrations (STLCs) and TTLCs as set by DOHS (see results in Table I).

On March 26, 1984, UC RFS took six additional samples: two groundwater and four surface water. These samples were taken at the behest of California RWQCB, who expressed concern with regard to "beneficial uses" of San Francisco Bay waters. RWQCB also wanted to resolve the issue of mercury and metal contamination (see results Table II). The possible adverse affects to aquatic life were not addressed by the RWQCB.

Although the March 26, 1984, sampling results appear to show no mercury or metal contamination as previously thought, no samples were analyzed for DDT and no sediment samples were taken from the marsh area-- the principal runoff route for the Stauffer - UC RFS facilities.

According to UC RFS, the reasons for not collecting sediment samples or analyzing for DDT were as follows: 1) costs must be borne by UC, 2) soil sampling should only be conducted if surrounding water samples identified a potential metal threat via external leaching from the RFS site, and 3) previous sampling, according to UC, had shown no mercury or DDT contamination (15).

Sample analyses for all sampling efforts are summarized in Table I & II. Sample locations are shown on Exhibit 3 (Sample Location Map). Mercury, as well as all other metal concentrations reported, fall below MCLs as set by RWQCB and STLCs as set by DOHS.

Direct Contact/Fire and Explosion:

The site is securely fenced so the direct contact threat appears to be minimal.

In 1950 when UC burned the land to clear it of weeds, numerous "explosions" occurred although there is no documented evidence as to how serious these incidents were. Agency personnel from CDFG and Cal OSHA believed these explosions were due to the possible on-site presence of fulminate of mercury. Subsequent sampling conducted by DOHS in 1981 and 1982, detected no fulminate of mercury at UC RFS. There is no available file information to indicate a present danger of fire and explosion.

Waste Type/Quantity:

One of the principal products used by Cal Cap was fulminate of mercury, which is highly explosive at its 80°F melting point, and soluble in alcohol, ammonium hydroxide, and water. Fulminate of mercury, $\text{Hg}(\text{CNO})_2$, is a grey, crystalline powder used for explosive caps and detonators and is also known as mercury cyanate. The Department of Transportation (DOT) has banned transportation of dry fulminate of mercury because it is very sensitive to heat, impact, and friction.

There is no known documentation record pertaining to the quantities of fulminate of mercury or other potentially hazardous materials handled on-site. The size and number of storage and treatment facilities is also not known. Fulminate of mercury was reported to have been used at only one location at the Cal Cap facility, far removed from the major munitions-manufacturing area (Building 102).

There is no available documentation to indicate that DDT or metals were ever handled at the Cal Cap facility.

Ground Water:

The underlying aquifer of concern is approximately 100 feet below ground surface. Ground-water movement was originally bayward (west) from the site, but pumping has caused the water table to be drawn below sea level and the hydraulic gradient to be reversed. Intrusion of sea water has resulted in non-potable brackish ground water with a salt content approximately one fourth that of bay water. Two wells were drilled (date not documented) on RFS as part of a research project (wells near buildings 167 and 174, refer to Exhibit 3). These wells were sampled in early April 1984 by EAL Corporation, Richmond, California. Mercury, as well as all other metals reported, fall below MCLs as set by RWQCB (7). (Table II).

No data are available on industrial or agricultural use of ground water. Potable water supplies are imported by the East Bay Municipal Utility District to meet drinking water requirements of the Richmond area. There are no municipal wells in Richmond and the extent of small water system and private well use is not currently known.

Net precipitation for the Richmond area is 5 inches per year (9).

It is unlikely that the ground water route would score higher than 28.5 on the MITRE HRS model because of the potentially small target value.

Surface Water:

The surface runoff waters from the RFS are directed to two small storm drains (East storm drain, West storm drain) which empty into the marshland (Exhibit 3). Although flow in these storm drains occurs during periods of heavy precipitation, water can flow at other times of the year when high tides back water up into the storm drains. In addition to the small storm drains at RFS, there are two large sloughs which drain into the marshland (North Runoff Point and South Runoff Point) as indicated on Exhibit 3. These are large open channels measuring approximately 12 feet in width and 8 feet in depth. One is concrete lined and both service the runoff from the City of Richmond and adjacent industrial areas. The RFS site does not drain into these sloughs. The marsh in turn, drains into San Francisco Bay through a single opening in a built up dike or raised causeway that serves as the roadbed for the Santa Fe railroad track. During periods of flooding, tide waters enter through the opening and flood the marshland. During neap tide or heavy rain, flow through the opening is reversed, draining the marshland (4).

Analytical results for surface water samples drawn March 26, 1984 are presented in Table II. The analyses were performed by EAL Laboratory, Richmond, California (7). These analytical results indicate concentrations of mercury just at the detection limit at the RFS east storm drain outflow point (Sample 4), but upon mixing with slough runoff in the marshland, the concentration drops below the analytical detection limit (Samples 1, 3).

The average slope of the site and surrounding terrain is 2% while the one year, 24 hour rainfall ranges from 2.1 to 3 inches (10, 11).

There are no known endangered species habitats within the RFS marsh area nor are there other wetlands within a one-mile radius (10).

The RFS lies adjacent to San Francisco Bay. The beneficial uses of the Bay are (19)

- Water contact recreation
- Non-contact recreation
- Wildlife habitat
- Preservation of rare and endangered species
- Estuarine habitat
- Fish migration and spawning
- Industrial service and process supply
- Shellfish harvesting
- Navigation
- Commercial and sport fishing

It is unlikely that the ground-water/surface water routes would score higher than 28.5 on the MITRE HRS model because of the potentially small target values associated with these routes.

Other Factors/Other Agency Involvement:

According to CDFG personnel, DDT levels at the UC RFS site are too low to warrant investigation (17).

Both RWQCB and DOHS have been involved with this site since 1980. Please refer to the Apparent Problem section for a detailed discussion.

c. Conclusions and Recommendations

The 113-acre RFS site was previously owned by Cal Cap, who used fulminate of mercury in their munitions process. UC purchased the property in 1950. Even though the sale agreement stated the site be cleared of all hazardous materials, several explosions of undocumented intensity occurred when the site was burned between 1950 and 1953 to clear it of weeds. An investigation was later initiated by DOHS, Hazardous Material Management Section.

Analyses of marshland soil, sampled by DOHS in 1981, showed levels of mercury and DDT above DOHS TTLC action levels. Part of the marshland was formerly a Stauffer Chemical landfill and UC suspected that residual DDT might be left from the land fill operation (12). Metal concentrations were below DOHS TTLC action levels throughout the site. Subsequent DOHS soil samples, taken in 1982, confirmed that metal concentrations were below DOHS action levels; however, mercury and DDT in the marshland were below detection limits. The contradiction in the levels of mercury and DDT between 1981 and 1982 analyses has not been resolved. Basing their recommendation on the 1982 analytical results, the DOHS concluded that there was no mercury or DDT contamination on-site and removed the UC RFS from the list of DOHS abandoned waste sites (3). No further soil sampling efforts have been conducted at the UC RFS.

In 1984 UC conducted water sampling of selected sites. This sampling was done at the request of RWQCB who expressed concern relative to the lateral and vertical extent of both soil and ground-water contamination by mercury, metals, and DDT. UC did not test for DDT, nor did they collect soil samples at any location. The rationale of UC RFS was as follows: 1) UC must bear the cost, and 2) previous testing had confirmed that there was no on-site DDT or mercury contamination. Analyses of ground water and surface water showed no metal contamination above RWQCB MCL limits.

FIT recommends a low priority site inspection to be conducted at UC RFS to:

- o Determine the extent of possible mercury contamination;
- o Determine the extent and level of DDT in the marshland area;
- o Establish potential sampling locations;
- o Use the above information to determine the potential threat to the public and the environment;
- o Evaluate the eligibility of the site for HRS scoring and inclusion on the National Priorities List (NPL);

2. FIT Review/Concurrence: *Chen Lichun, 6/2/87* *Barbara L. McCoy 1/1/87*
3. EPA Recommendation for Further Action:
4. Response Termination: No further action ☐; Active ☒; Pending ☐.

Justification:

References

- 1) Memo to file from Phillip, California Department of Health Services, Re: California Cap Company, 47th St. & Hoffman Blvd., Richmond, CA. (currently UC Richmond Field Station), July 18, 1980.
- 2) Miscellaneous facility map, California Regional Water Quality Control Board files, date unknown.
- 3) Letter to J. Shively, Manager, College of Engineering, Richmond Field Station (RFS), University of California (UC), from Charles White, Regional Administrator, North Coast Region, Hazardous Management Branch, California Department of Health Services, Re: Delisting of site, December 17, 1982.
- 4) Letter to Dr. Lester Feldman, California Regional Water Quality Control Board, from Professor J.F. Thomas, Ph.D., PE Chairman, Sanitary Environmental Coastal, Hydraulic Division, Department of Civil Engineering, UC Berkeley, Re: RFS Delisting, Ground/Surface Water Sampling, September 18, 1984.
- 5) Laboratory Analytical Results, Hazardous Materials Laboratory, California Department of Health Services, February 19, 1981.
- 6) California Regional Water Quality Control Board, "Water Quality Objectives" and Hazardous and Designated Levels for Chemical Constituents, by Jon B. Marshack, Environmental Specialist, Central Valley Region, 1985.
- 7) Analysis Report, EAL Corporation, Richmond, Lawrence Denfold, Program Manager, Environmental Science Department, May 7, 1984.
- 8) Phone conversation with Chris Lichens, Ecology and Environment, Inc., to Mel Yee of California Department of Health Services Sanitary Engineering Branch, August, 28, 1986.
- 9) Climatic Atlas of the United States, U.S. Department of Commerce, Environmental Science Services Administration, Environmental Data Service, 1968.
- 10) Inventory Worksheet, California Department of Health Safety, Dirk Drudgeon, June 17, 1981
- 11) Rainfall Frequency Atlas of the United States, U.S. Department of Commerce, Weather Bureau, May 1961.
- 12) Rationale for the Choice of Sampling Stations at the UC RFS, California Department of Health Services, Nancy Marsters, February 24, 1981.
- 13) Phone conversation with Robin Breuer, California Regional Water Quality Control Board, January 22, 1986.
- 14) Sampling Plan, California Department of Health Services, Table I, 1981.

DEPARTMENT OF HEALTH SERVICES

101 BERKELEY WAY
OAKLEY, CA 94621

15/540-2043

Certified No. P295 262 650
December 17, 1982

Mr. John Shively, Manager
College of Engineering
Richmond Field Station
University of California
47th & Hoffman Blvd.
Richmond, CA 94804

Dear Mr. Shively:

An extensive soil sampling was conducted at your facility on June 24, 1982 by Sonia S. Low of the Hazardous Waste Management Branch with the cooperation of Larry Bell of your staff. The analysis results of the samples taken reveal no mercury contamination; therefore, no on-site cleanup is required. We are therefore recommending that this site be removed from our list of abandoned hazardous waste disposal sites.

For your information, enclosed are the Hazardous Materials Laboratory reports, a sampling plan and a map where samples were taken.

Should you have any questions, please feel free to contact Sonia S. Low at (415) 540-2060.

Sincerely,

for Charles A. White, P.E.
Regional Administrator
North Coast Region
Hazardous Waste Management Branch

Attachments

cc: Paul Blais
U.S. EPA

Harold Singer
RWQCB

Daniel Bergman, Dir.
Contra Costa Co. Health

ATTACHMENT A

July 13, 1982

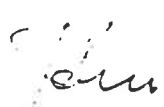
BEN GONZALES
Environmental Health & Safety

Subject: Alleged Hazardous Chemical Waste

For information, a Ms. Sonia Low of the Hazardous Waste Management division of the State Department of Health Services, 2151 Berkeley Way, Berkeley, California, 94707, (415) 540-2043, came out to the Field Station on June 24. This is a follow up on work previously done by the state's now defunct Abandoned Site Project. She took eighteen quart samples for subsequent analysis by the state in their search for fulminate of mercury, rumored to be left on the site by the California Cap Company before they sold the land to the University.

Ms. Low stated that the state analysis will be completed and reported back to me in about two months. If they find an above tolerance level on site, then the University will have the obligation to pay for correcting the problems.

Attached is a copy of the State's sampling record. Please call if you have questions.


John R. Shively
Manager

JRS:mw
Attachment

cc: H. Wall, RFS
Dean R. Oliver, ORS

HAZARDOUS WASTE

SURVEILLANCE AND COMPLIANCE REPORT



DATE June 24, 1982

IP NAME CALPAP SITE / UNIVERSITY OF
CA - RICHMOND FIELD STATION SITE CLASSIFICATION ☐ I ☐ II-1 ☐ II-2 ☐ III
☐ Other _____
DRESS 47th and HOFFMAN BOULEVARD
RICHMOND, CA 94801 SITE PERMIT NO. _____

Purpose : Extensive Soil Sampling Program (to determine the extent of contamination).

Background : Abandoned Site Project (ASP) became concern after the Department of Fish and Game, CAL-OSHA, and the San Pablo Sanitary District concerned about the possibility of mining-pollutant deposits remaining on site. ASP had taken sludge samples indicated that site was contaminated with mercury, arsenic, copper, zinc and lead. The problem was then referred to the Chemical Support and the Surveillance and Enforcement staff (see attached historical background prepared by ASP).

Persons Present :

John Shively - Manager
Larry Bell - Draftsman
Jonia Low - DOHS / HWMB

Samples Collected : 17 samples were collected and were taken to Hazardous Materials Laboratory. See attached HMTS-official Sample Receipt, HMT Sample Analysis Request, and map for sample locations.

Remarks : Jim Shively wanted the soil contamination problem be resolved, if any. He said that because of the publicity about the problem, their employees have a safety concern in their jobs and it causes doubt in the minds of sponsors about their ability to conduct research.

SPECTOR

Jonia Low

DATE

July 15, 1982

OFFICIAL SAMPLE RECEIPT

HAZARDOUS MATERIALS MANAGEMENT SECTION

7 Temple Street
 Sacramento, 95814
 (916) 223-2330

744 P Street
 Sacramento, 95814
 (916) 322-2337

2151 Berkeley Way
 Berkeley 94704
 (415) 843-7900

Date
 6/21/82

NAME OF THE SITE
 UNIVERSITY OF CALIFORNIA - COLLEGE OF ENGINEERING - RICHMOND FIELD STATION
 ADDRESS
 47th & HOFFMAN BOULEVARD
 CITY
 RICHMOND
 ZIP CODE
 94804
 PERSON INTERVIEWED
 NAME
 SHERIDAN
 POSITION
 MANAGER

Items listed below were collected as official samples on this date as authorized by Section 66329, California Administrative Code, Title 22.

Quantity	Unit Size	Material	I.D. Number
1	quart	composite (surface) taken S.E. of Bldg 167 - DOHS referred as Area A	SSL #001
1	quart	subsurface (2') soil sample taken where SSL #001B was taken	SSL #001C
1	quart	composite (surface) taken N.W. of Bldg 167 - DOHS referred as Area B	SSL #002B
1	quart	subsurface (2') taken where SSL #002B was taken	SSL #002C
1	quart	composite (surface) taken West of SSL #002B - DOHS referred as Area B	SSL #002E
1	quart	subsurface (2') taken where SSL #002E was taken	SSL #002F
1	quart	composite (surface) sample taken 100 ft North of the biological sludge beds - DOHS referred as Area C	SSL #003B
1	quart	composite (surface) sample taken in the middle of the undeveloped vacant lot (West of the biological sludge area & P&H Property line) - DOHS Area	SSL #004B
1	quart	subsurface (2') taken 100 ft North of the biological sludge beds area - DOHS Area	SSL #004C

acknowledged by

J. R. L. Lundy
 Signature

By

Louise S. Low

Authorized Agent

5701

RL

LABORATORY REPORT

415-546-3003

Date Received

by Laboratory 6/28/82

Collector's Name Sonia S. Low

Sampling Location Cal State College of Eng. Richmond Falls Collector's Sample # SSL 001A to

47th and McDevine Blvd. Richmond, CA 94804

SSL 002B

Analytical Procedure: Metals are digested with nitric acid followed by X-ray fluorescence analysis. Refer to HML Methods. Other tests:

Concentration Units: Solids, ug/g; Liquids, ug/mL

Other Tests

L#	5591	5700	5701
Collector's #	SSL 001A ✓	SSL 001A ✓	SSL 002B ✓
--Titanium	-	-	-
--Vanadium	-	-	-
--Chromium	-	-	-
--Manganese	105	114 ± 28	215 ± 21
--Iron	13700	14700	20500
--Cobalt	-	-	-
--Nickel	2025	10 ± 8	-
--Copper	245	209 ✓	201 ✓
--Zinc	110 ± 10	119	150
--Arsenic	10 ± 4	-	32 ± 9
--Selenium	-	-	-
--Bromine	-	-	-
--Rubidium	14 ± 2	14 ± 2	1152
--Strontium	10 ± 4	23 ± 4	23 ± 4
--Tantalum	-	-	-
--Mercury	-	-	-
--Lead	-	-	135
--Bismuth	-	-	-
--Molybdenum	-	-	-
--Silver	-	-	-
--Cadmium	-	-	-
--Tin	-	-	-
--Antimony	-	-	-
--Iodine	-	-	-
--Cesium	-	-	-
--Barium	15 ± 31	40 ± 2	110 ± 20
--Thorium	-	-	-

CALIFORNIA REGIONAL WATER

DEC 8 1982

STATE OF CALIFORNIA

XRF method
dilution factor was
1 to 100 ml
of soil w

Metals having threshold limit concentrations in CAM

Note: (-) = Not detected

(blank) = Not determined

Error is ±10% or less unless otherwise stated.

Analyst's Signature

Signature of Supervising Chemist

David McNamee

12/3/82
(Date)

JML

12-82
(Date)

California Department of Health Services
Hazardous Materials Laboratory

HML# 5702 to
5704

LABORATORY REPORT

Date Received

by Laboratory 6/24/82

Collector's Name Sonia & Santos Low

Sampling Location CAL CAP/UC College of Eng Richmond Falls Collector's Sample # SSL 002C to
47th and Hoffman Blvd Richmond CA 94804 SSL 005C

Analytical Procedure: Metals are digested with nitric acid followed by X-ray fluorescence analysis. Refer to HML Methods. Other tests: _____

Concentration Units: Solids, ug/g; Liquids, ug/mL

Other Tests

L#	5702	5703	5704
Collector's #	SSL 002C	SSL 005B	SSL 005C
--Titanium	-	-	-
--Vanadium	-	-	-
--Chromium	32 ± 22	-	43 ± 24
--Manganese	1340	908	453
--Iron	10200	13100	16200
--Cobalt	-	-	-
--Nickel	73 ± 10	14 ± 9	37 ± 10
--Copper	44 ± 4	152	-
--Zinc	<4	232	20 ± 6
--Arsenic	-	21 ± 8	-
--Selenium	-	-	-
--Bromine	-	-	-
--Rubidium	17	17	14 ± 2
--Strontium	20 ± 0	24	10 ± 4
--Tantalum	-	-	-
--Mercury	-	-	-
--Lead	-	121 ± 14	-
--Bismuth	-	-	-
--Molybdenum	-	-	-
--Silver	-	-	-
--Cadmium	-	-	-
--Tin	-	-	-
--Antimony	-	-	-
--Iodine	-	25 ± 18	-
--Cesium	-	-	-
--Barium	124 ± 36	133 ± 34	122 ± 36
--Thorium	-	-	-
U	-	11 ± 4	-

Metals having threshold limit concentrations in CAM

Note: (-) = Not detected

(blank) = Not determined

Error is ±10% or less unless otherwise stated.

Analyst's Signature

David M. Mendenhall

Signature of Supervising Chemist

[Signature]

12/3/82
(Date)

12-6-8
(Date)

LABORATORY REPORT

Date Received

by Laboratory 6/24/82

Collector's Name Sonia S. Low

Sampling Location CPL (CPL) College of Eng. Richmond Field
47th and Hoffman Blvd. Richmond, Ca. 94804

Collector's Sample # SSL 00461 to

SSL 0046

Analytical Procedure: Metals are digested with nitric acid followed by X-ray fluorescence analysis. Refer to HML Methods. Other tests:

Concentration Units: Solids, ug/g; Liquids, ug/mL

Other Tests

	5705	5706	5707
Collector's #	SSL 00461 ✓	SSL 00462 ✓	SSL 00463 ✓
-Titanium	-	-	-
-Vanadium	-	-	-
-Chromium	20 ± 24	25 ± 24	26 ± 24
-Manganese	205	215	243
-Iron	15000	12000	16000
-Cobalt	-	-	-
-Nickel	54 ± 10	50 ± 10	51 ± 10
-Copper	26 ± 6	21 ± 6	12 ± 6
-Zinc	45	63	31 ± 6
-Arsenic	19 ± 6	16 ± 4	-
-Selenium	-	-	-
-Bromine	-	-	1
-Rubidium	15	24 ± 4	15
-Strontium	35	41	31 ± 4
-Tantalum	-	-	-
-Mercury	-	-	-
-Lead	47 ± 12	-	-
-Bismuth	-	-	-
-Molybdenum	-	-	-
-Silver	-	-	-
-Cadmium	-	-	-
-Tin	-	-	-
-Antimony	-	-	-
-Iodine	-	-	-
-Cesium	-	-	-
-Barium	176 ± 36	42 ± 36	111 ± 36
-Thorium	-	-	-
-Yttrium	12 ± 4	12 ± 4	12 ± 4
-Zirconium	12 ± 4	12 ± 4	-
-Niobium	-	-	-
-Manganese	-	-	-
-Iron	-	-	-
-Copper	-	-	-
-Zinc	-	-	-
-Nickel	-	-	-
-Chromium	-	-	-
-Vanadium	-	-	-
-Titanium	-	-	-

Metals having threshold limit concentrations in CAM

Note: (-) = Not detected

(blank) = Not determined

Error is ±10% or less unless otherwise stated.

Analyst's Signature

David Mahangle

12/3/82
(Date)

Signature of Supervising Chemist

[Signature]

12-6-82
(Date)

5710

LABORATORY REPORT

Date Received

by Laboratory 6/24/82

Collector's Name Schia S. Low

Sampling Location CAL CAR/LC College of Eng. Richmond Field Sta Collector's Sample # SSL 006 C to
47th and Haight St. Richmond, CA 94803 SSL 006 B

Analytical Procedure: Metals are digested with nitric acid followed by X-ray fluorescence analysis. Refer to HML Methods. Other tests:

Concentration Units: Solids, ~~wt%~~ Liquids, ug/mL

	5708	5709	5710
Collector's #	SSL 006C	SSL 007B	SSL 008B v
Titanium	-	-	-
Vanadium	-	-	-
Chromium	20 ± 12	175 ± 20	-
Manganese	205	1.2 ± 0.4	203
Iron	10200	24200	19200
Cobalt	-	-	-
Nickel	70 ± 8	22 ± 10	26 ± 10
Copper	-	452	56
Zinc	70 ± 4	0.73	100
Arsenic	-	3.3 ± 1.3	15 ± 6
Selenium	-	-	-
Bromine	-	-	-
Rubidium	16	13 ± 4	14 ± 2
Strontium	24 ± 4	30 ± 4	25 ± 4
Tantalum	-	-	-
Mercury	-	-	-
Lead	-	925 v	82 ± 12
Bismuth	-	-	-
Molybdenum	-	-	-
Silver	-	-	-
Cadmium	-	-	-
Tin	-	-	-
Antimony	-	-	-
Iodine	-	-	-
Cesium	-	-	-
Barium	135 ± 36	213 ± 38	144 ± 36
Thorium	-	-	-
	12 ± 4	-	-

Other Tests

SSL - MAI -
JL - 006C - 056 B site location -
JL - 007B - 007 site location

Metals having threshold limit concentrations in CAM

(-) = Not detected

(blank) = Not determined

Error is ±10% or less unless otherwise stated.

Analyst's Signature

David Mubanga

12/3/82

(Date)

Signature of Supervising Chemist

[Signature]

12-6-82

(Date)

5713

LABORATORY REPORT

Collector's Name Serial 5 Low

Date Received

by Laboratory 6/25/82

Sampling Location Cal. Cal. - 1000 ft. E. of Highway 101 to
42 mi. and Highway 101 (101/101) - 4500 Collector's Sample # SSL 001B to
SSL 010C

Analytical Procedure: Metals are digested with nitric acid followed by X-ray fluorescence analysis. Refer to HML Methods. Other tests: _____

Concentration Units: Solids, ug/g; Liquids, ug/mL			
#	5711	5712	5713
Collector's #	SSL 001B	SSL 010A	SSL 010C
Titanium	-	-	-
Vanadium	-	-	-
Chromium	-	-	-
Manganese	42	41	127
Iron	2700	17700	11400
Cobalt	-	-	-
Nickel	46 ± 10	-	19 ± 5
Copper	327	572	-
Zinc	750	104	4
Arsenic	20 ± 5	21 ± 4	17 ± 0
Selenium	-	-	-
Bromine	13 ± 2	-	-
Rubidium	12 ± 2	14	-
Strontium	20 ± 6	20 ± 6	21 ± 2
Tantalum	-	-	-
Mercury	-	-	-
Lead	96 ± 14	26 ± 10	-
Bismuth	-	-	-
Molybdenum	-	-	-
Silver	-	-	-
Cadmium	-	-	02 ± 12
Tin	-	-	-
Antimony	-	-	-
Iodine	-	-	-
Cesium	-	-	40 ± 14
Barium	73 ± 34	108 ± 34	90 ± 34
Thorium	-	-	-

Other Tests

MAN SITES

TR - NE - 010C

YES - 007C NO

Metals having threshold limit concentrations in CAM
(-) = Not detected
(blank) = Not determined
Error is ±10% or less unless otherwise stated.

Analyst's Signature

David Mahan

Signature of Supervising Chemist

[Signature]
JNV

12/3/82
(Date)

12-6-82
(Date)

5715

by Laboratory 6/28/71

Sampling Location CAL CAP/CC College of Eng. Richmond Field Sta Collector's Sample # SSL 011A to
47th and Holford Blvd. Richmond CA 94803 SSL 011C

analytical Procedure: Metals are digested with nitric acid followed by X-ray fluorescence analysis. Refer to HML Methods. Other tests: _____

Other Tests

Metals having threshold limit concentrations in CAM

Note: (-) = Not detected

(blank) = Not determined

Error is $\pm 10\%$ or less unless otherwise stated.

Analyst's Signature

Signature of Supervising Chemist

David M. Lang

(2/3/52)
(Date)

Jan

انتی

12-6-8
(Date)

HML No. 5699
To 5704

HAZARDOUS MATERIALS SAMPLE ANALYSIS REQUEST

FIELD SECTION

Peninsula Sintered Soil

Date Sampled 6/24/82

Time 1:45 Hours

LOCATION OF SAMPLING

47th and Hoffman Boulevard Richmond CA

City Richmond State CA Zip 94804

FIELD INFORMATION**

No. (b)(1)	Collector's Sample No.	Type Of Sample*	FIELD INFORMATION**
<u>99</u>	<u>SSL C01B</u>	<u>soil</u>	<u>surface composite taken S.E. of Bldg 167 - Area A</u>
<u>100</u>	<u>SSL C01C</u>	<u>soil</u>	<u>subsurface (2') taken where SSL C01B was taken</u>
<u>101</u>	<u>SSL C02B</u>	<u>soil</u>	<u>surface composite taken N.W. of Bldg 167 - Area B</u>
<u>102</u>	<u>SSL C02C</u>	<u>soil</u>	<u>subsurface (2') taken where SSL C02B was taken</u>
<u>103</u>	<u>SSL C05B</u>	<u>soil</u>	<u>surface composite taken West of SSL C001C Area C</u>
<u>104</u>	<u>SSL C05C</u>	<u>soil</u>	<u>subsurface (2') taken where C05B was taken</u>

Tests Requested:

Mercury, Copper, Zinc, Lead As (AA) for all samples
in addition with heavy metals SSL C01A & SSL C01C. All
analyzed for DDT

Signature of Custody:

Santha Paul
Signature

WMS
Title
Chem I
Title

6/24/82 - 6/24/82
Inclusive Dates
6/28/82 -
Inclusive Dates

Signature

Title

Inclusive Dates

Signature

Title

Inclusive Dates

Remarks

NDDE
(e.g., duplicate sample given to company, etc.)

LABORATORY SECTION

Received By

Tan U

Title

PH Chem III

Date

6-28-82

Sample Allocation:

☐ HML

☐ SCBL

☐ LBL

☐ Other

Date

Analysis Required

Hg, Cu, Zn, Pb, As & A/A for all
samples; DDT for HML 5714 & 5715
only Metal Scan

Indicate whether sample is sludge, soil, etc.:

Use back of page for additional information:

Orig - Lab. Dup - File Trip - Inspector

HAZARDOUS MATERIALS SAMPLE ANALYSIS REQUEST

FIELD SECTION

Date Sampled _____ Time _____ Hours _____

LOCATION OF SAMPLING _____

Tel. No. _____

Address _____ Number _____ Street _____ State _____ Zip _____

Collector's Sample No. _____ Type Of Sample _____ FIELD INFORMATION**

1. 5100 AB1 soil surface composite taken 150 ft N of the bldg. sludge bed

2. SSL 000 B2 soil " " in the middle of the undisturbed

3. SSL 004 C soil vacant lot - J Area

4. SSL 006 C soil subsurface (2') taken 25' N of bldg. 100 - Area D

5. SSL 007 B soil surface composite taken under front porch of Bldg. 100 - E Area

Requested: _____

Custody: Antonia Low Analyst 6/24/82 - 6/26/82
Pamela Oliver Chem I 6/28/82 - _____
 Signature Title Inclusive Dates
 Signature Title Inclusive Dates
 Signature Title Inclusive Dates
 Signature Title Inclusive Dates

Remarks: None
 (e.g., duplicate sample given to company, etc.)

LABORATORY SECTION

By _____ Title _____ Date _____
 Allocation: ☐ HML ☐ SCBL ☐ LBL ☐ Other _____ Date _____
 Required _____

HML No. 5710
5713

HAZARDOUS MATERIALS SAMPLE ANALYSIS REQUEST

I: FIELD SECTION

Location of Sampling: Area F Date Sampled: 6/28/82 Time: 10:00 Hours: 10:00
 Name: _____ Tel. No.: _____
 Address: _____ Number: _____ Street: _____ State: _____ Zip: _____

No. Only	Collector's Sample No.	Type Of Sample*	FIELD INFORMATION**
<u>5710</u>	<u>SSL 008B</u>	<u>soil</u>	<u>surface composite taken from gravel space under Bldg 102 - Area F</u>
<u>5711</u>	<u>SSL 009B</u>	<u>soil</u>	<u>surface composite taken west of Bldg 102 - Area F</u>
<u>5712</u>	<u>SSL 010A</u>	<u>soil</u>	<u>surface taken west of Bldg 102 - I Area</u> <u>West of SSL #009B</u>
<u>5713</u>	<u>SSL 010C</u>	<u>soil</u>	<u>subsurface (-) taken where SSL #010B was to</u>

Additional Requests: see 10/4

Custody: James Antonio Sosa Signature: James Antonio Sosa Title: WHS Chem I Inclusive Dates: 6/21/82 - 6/28/82
 Signature: _____ Title: _____ Inclusive Dates: _____
 Signature: _____ Title: _____ Inclusive Dates: _____
 Signature: _____ Title: _____ Inclusive Dates: _____
 Remarks: None (e.g., duplicate sample given to company, etc.)

II: LABORATORY SECTION

Requested By: _____ Title: _____ Date: _____
 Allocation: ☐ HML ☐ SCBL ☐ LBL ☐ Other _____ Date: _____
 Analysis Required: _____

HAZARDOUS MATERIALS LABORATORY

LABORATORY REPORT RadialTO: Sonia Santos Low
(name of person requesting analysis)HML #

5	7	1	4	-
---	---	---	---	---

5715

COPY TO _____

COLLECTOR'S SAMPLE # SSL 011A - SSL 011CDATE OF REPORT

0	8	/	9	8	2
---	---	---	---	---	---

LOCATION OF SAMPLE COLLECTION:

DATE COLLECTED

0	6	/	2	8	2
---	---	---	---	---	---

NAME CAL CAP/ UC COLLEGE OF ENGINEERING RICHMOND FIELD STA mo day yrADDRESS 47th & HOFFMAN BLVD. Richmond, CA 94804
number street city state zipANALYTICAL PROCEDURES USED: Sample(s) extracted w hexane. Constituents
analyzed by GC w ECD on OV-17/210 Column Temp. program 180-220°C
20ul vol. inj working std is DDT series Std. DREFERENCE: HML Methods (refer to AOAC, 13th Ed., 29.013)

ANALYSIS RESULTS:

DDT Analysis

HML #	5714	5715	Detection
Collector's #	SSL 011A	SSL 011C	Limit, µg/g
2,4'-DDE	—	—	0.2
4,4'-DDE	—	—	0.2
2,4'-DDD	—	—	0.2
2,4'-DDT	—	—	0.3
4,4'-DDD	—	—	0.2
4,4'-DDT	—	—	0.3

(-) = not detected

ANALYSTS' SIGNATURES:

SIGNATURE OF SUPERVISING CHEMIST

1. David Mahabadi 8/19/82
dateTamara 8-19-82
date2. _____
date

MAINT
RECORDS
RECORDS

1025 Shattuck Ave.
Rm. 209
Berkeley, CA 94701

2/18/81

Dear Mr. Larson,

Attached is a map of the U.C. Richmond Field Station with red dots on it indicating where soil samples will be taken.

A trowel, a spade, and an auger will be used to take soil samples at each sampling station. Since this is a preliminary inspection, disturbances will be minimal. All holes made will be refilled.

We hope that our sampling at these locations, (beginning at 1:30 pm on 2/19/81), will not interfere with the activities at the Field Station. If there is a problem, or if you have any questions, please contact me at 540-3007. Thankyou for your cooperation.

With Best Wishes,

Philip Mellen

Philip Mellen - Research Assistant

RICHMOND FIELD
STATION
FEB 18 1981
UNIVERSITY OF
CALIF.

Copy =

Ward

2-19-81

3-26-81

Dear Mr. Shirley,

Here are copies of the lab results from samples taken at the Richmond Field Station on 2-19-81, and the accompanying report about the site. Please phone me if you have any comments about what I've written. The mercury concentrations found in the composite samples from the marsh and from beneath Bldg 128 are significant, and some sort of follow-up assessment of the site will be necessary. I haven't discussed this with anyone from our enforcement division yet, and so am not sure what this might entail. Hopefully the contamination is very localized. In any case I will do my best to have things move quickly.

Very Truly Yours,

Philip Allen

RICHMOND FIELD
STATION

MAR 27 1981

UNIVERSITY OF
CALIF.

California Cap Company

47 St. & Hoffman Blvd.
Richmond, California

Most of the site currently owned and operated by the University of California (U.C.) as its Engineering Field Station, was previously owned by the California Cap Company. The U.C.'s real estate office records show that this property formerly consisted of several individual lots owned by different people. Since the 1840's the eastern half, (approximately), of what is now the university's property housed several explosives manufacturing companies. The western half (approximately) of this land had been developed for residential use.

The California Cap Co. was established after its owners purchased some land on the site from Hercules Powder Co. at the turn of the century. By 1920 the California Cap Co. had bought up the other companies and became the only explosives manufacturer at the site. One of its principal activities was the manufacture of fulminate of mercury, $\text{Hg}(\text{CNO})_2$, an explosive. The company went out of business shortly before selling its property to the U.C. in 1950.

The Department of Health Services' Abandoned Site Project (ASP; Hazardous Materials Management Section) became concerned about the site after staff of the Department of Fish and Game, Cal OSHA, and the San Pablo Sanitary District all concurred about the possibility of fulminate of mercury deposits remaining on the site. This is of concern both because of the risks of explosions occurring, and because of the risks of mercury contamination of the soil. Fulminate of mercury is very sensitive to heat (melting point: 80°F), impact, and friction when dry. It is soluble in water, alcohol, and ammonium hydroxide.

Don Horning, the first superintendent of the U.C. Engineering Field Station, said that California Cap Co. had agreed to decontaminate the site of $\text{Hg}(\text{CNO})_2$ prior to selling it to the U.C. He said that the major part of this operation was the removal of the fulminate plant from the site. No significant explosions have occurred over the thirty-one years that the U.C. has owned the site. The existence of an aquifer only three feet beneath the ground surface makes it likely that any once-present contaminants would have undergone some leaching out of the soil over time.

ASP staff have visited the site twice. Staff from the Contra Costa County Department of Health Services joined ASP staff on the second visit at which time preliminary soil samples were taken at six different stations. All samples ~~were~~ were composites taken from a depth no greater than one foot. Samples were analyzed for the presence of mercury. Significantly high mercury concentrations were found in two of the composite samples taken (105 ppm for the sample taken from beneath bldg 128 - see map; and 23 ppm for the composite sample from the salt marsh area). Follow-up sampling at the site must be conducted to determine the extent of contamination and what corrective actions might be necessary.

LABORATORY REPORT

TO: Mellen M. Martini - ASP
(name of person requesting analysis)

HML # 3160
- 3164

COPY TO Dart

COLLECTOR'S SAMPLE # 1 - 7

DATE OF REPORT 03/28/81

LOCATION OF SAMPLE COLLECTION:

DATE COLLECTED 02/21/81
mo day yr

NAME Richmond field station

ADDRESS _____
number street city state zip

ANALYTICAL PROCEDURES USED: Samples were analyzed by VMA, then
checked and measured by AA fluorimeter

REFERENCE: HML Mail-d

ANALYSIS RESULTS:

HML #	Collector's Sample #	Hg ug/g
3160	1	0.4
3161	2	105
3162	4	1.05
3163	6	23
3164	7	0.24

WIC
P/M

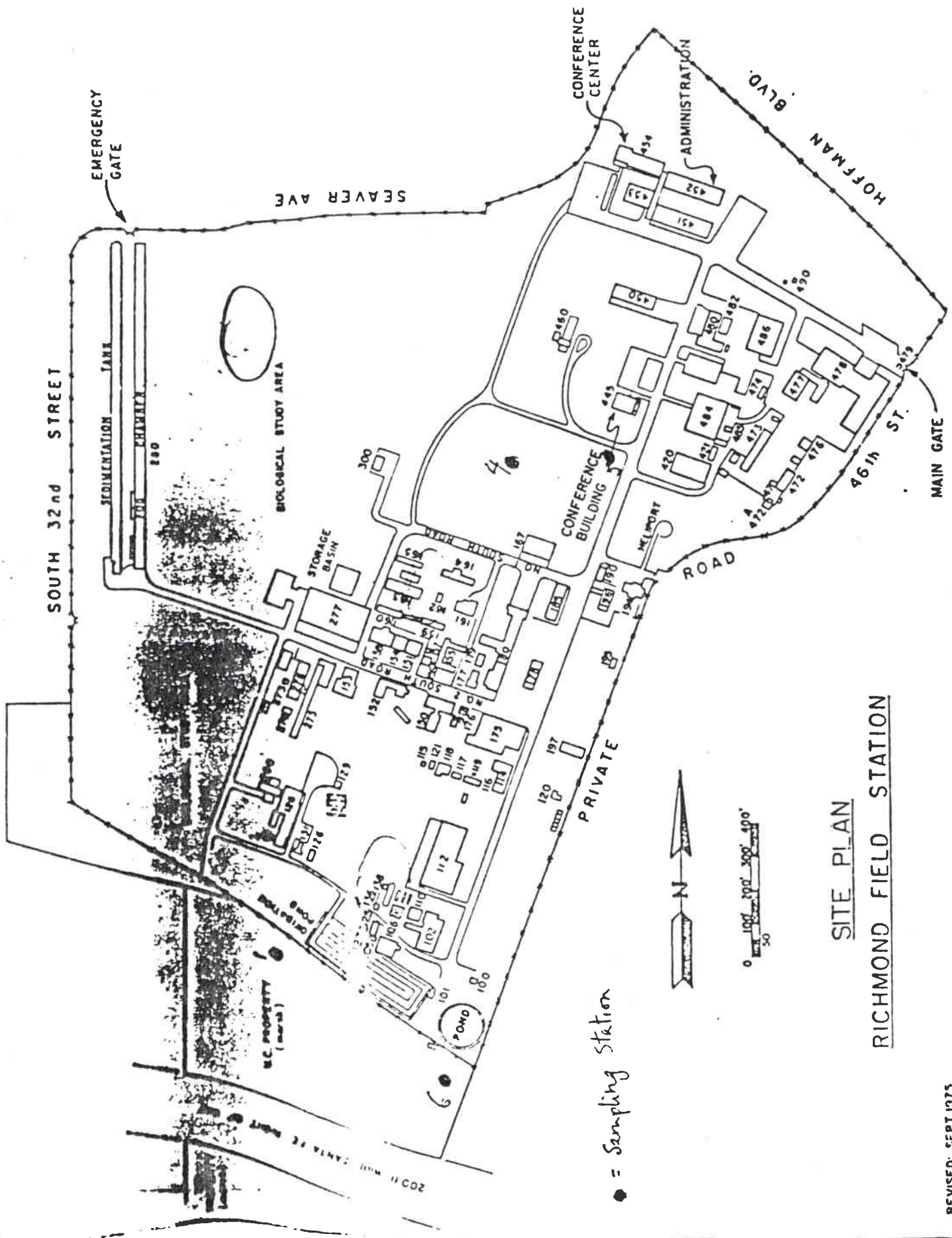
ANALYSTS' SIGNATURES:

SIGNATURE OF SUPERVISING CHEMIST

1. [Signature] 3-18-81
date

[Signature] 3/18/81
date

2. _____
date



SITE PLAN
RICHMOND FIELD STATION

REVISED: SEPT 1975
MAY 21, 1976

March 27, 1981

BEN GONZALES
Environmental Health & Safety


Subject: Fulminate of Mercury Investigation

Attached is a letter dated March 26, 1981, received from Mr. Phillip Mellon of the State Department of Health Services, Abandoned Site Project. It reports significant findings of mercury deposits as the result of their search for evidence of fulminate of mercury remaining from the earlier California Cap Company operation at the Field Station site.

Because of these early findings, Mr. Mellon has asked to pursue the investigation further to which I have agreed. If they establish the existence of dangerous amounts of fulminate of mercury, then it appears that the cost of corrective action will fall on the University.

I asked Mr. Mellon to contact you to obtain EH&S coordination. His address is 1625 Shattuck Avenue, Room 209, Berkeley 94704. His telephone number is 540-3007.

Please call if you have any further questions.



John R. Shively
Manager

JRS:vg
Attachment

cc: D. Larson, Chrm Safety Comm.
Dean R. Oliver, ORS

Appendix C - Plate 1-1, Previous and Proposed Soil Sampling Locations

Appendix D - Total Threshold Limit Concentrations (TTLCs)

Total Threshold Limit Concentrations

<u>Metal</u>	<u>TTLT (Wet-Weight)</u> <u>(mg/kg)</u>
Antimony and/or antimony compounds	500
Arsenic and/or arsenic compounds	500
Asbestos	1.0
Barium and/or barium compound (excluding barite)	10,000
Beryllium and/or beryllium compounds	75
Cadmium and/or cadmium compounds	100
Chromium (VI) compounds	500
Chromium and/or chromium (III) compounds	2,500
Cobalt and/or cobalt compounds	8,000
Copper and/or copper compounds	2,500
Fluoride salts	18,000
Lead and/or lead compounds	1,000
Mercury and/or mercury compounds	20
Molybdenum and/or molybdenum compounds	3,500
Nickel and/or nickel compounds	2,000
Selenium and/or selenium compounds	100
Silver and/or silver compounds	500
Thallium and/or thallium compounds	700
Vanadium and/or vanadium compounds	2,400
Zinc and/or zinc compounds	5,000

Appendix E - Nitrate Concentrations in Soils and Soil Solutions

Nitrate Concentrations in Some Soils and Soil Solutions

System Sampled	Nitrate-N		Reference
	mg/l	mg/kg	
Alfalfa-soil profile	-	<1.9	Shertz and Miller (1972)
Alfalfa-water table	1 - 44	-	Stewart et al. (1967)
Virgin grassland	0.1- 19	-	
Wheat fallow	5 - 9.5	-	
Irrigated land	0 - 36	-	
Cattle feedlots	0 - 41	-	
Marsh soil	0 - 0.14	-	Isirimah and Keeney (1973)
Unfertilized wheat	-	1- 30	Cooke et al. (1957)
Fertilized wheat	-	5- 40	
Bare fallow	-	10-120	Simpson (1962)
Subterranean clover	-	2- 15	
Potato field drainage	12 - 56	-	Saffigna and Keeney (1977)
Permanent pasture	-	2- 12	Thompson and Coup (1940)
Urine-affected area	-	120-640	
Anhydrous NH ₃ band	-	35-710	Chalk et al. (1975)
Corn root zone	-	1- 30	
Asparagus	38 -439	1- 30	Ayers and Branson (1973)
Celery	525	-	
Sugarbeets	264	-	
Potatoes	175 -536	-	
Irrigated lands	10 -215	-	Pratt et al. (1975)
Corn-300 cm	2 - 35	-	
Tile drains	6 - 18	-	Kohl et al. (1971)
Tile drains	1 - 62	-	Johnston et al. (1965)

Source: Scientific and Technical Assessments of Environmental Pollutants, Nitrates: An Environmental Assessment, A report prepared by the Panel on Nitrates of the Coordinating Committee for Scientific and Technical Assessments of Environmental Pollutants, Environmental Studies Board Commission, on Natural Resources, National Research Council, National Academy of Sciences, Washington, D.C. 1978.

Appendix F - Information on Wood Preservation Standards and Techniques

The Analysis of **EXISTING WOOD PRESERVING TECHNIQUES** and **POSSIBLE ALTERNATIVES**

METREK Division / The MITRE Corporation

B. FULLER
R. HOLBERGER
D. CARSTEAN
J. CROSS
R. BERMAN
P. WALKER

Contract Sponsor: U.S. Environmental Protection Agency
Contract Number: 68-01-4310
Project Number: 15060
Department: W-56

June 1977

AMERICAN WOOD-PRESERVERS' ASSOCIATION
STANDARD

(This Standard is under the jurisdiction of AWPAS Subcommittee P-4)

P5-89

STANDARDS FOR WATERBORNE PRESERVATIVES

Note: Standard P5-89 consists of four pages dated as follows: Pgs. 1-4, 1959

cope

These standards cover waterborne preservative formulations expressed on the oxide basis and prescribe maximum and minimum values of acceptability in either solid, paste, or solution formulations for use in the preservative treatment of wood.

1. ACID COPPER CHROMATE (ACC)

1.1 Acid copper chromate shall have the following composition:

Copper, as CuO	31.8%
Hexavalent chromium, as CrO ₃	68.2%

subject to the following tolerances:

1.2 The analytical composition of the solid, paste, liquid concentrate or treating solution forms of this preservative may vary within the following limits:

	Min.*
Copper, as CuO	28.0%
Hexavalent chromium, as CrO ₃	63.3%

1.3 The solid, paste, liquid concentrate or treating solution shall be made up of water soluble compounds selected from the following groups each with excess of 95 percent purity on an anhydrous basis:

Divalent copper—e.g., copper sulfate
Hexavalent chromium—e.g., sodium or potassium dichromate, chromium trioxide

The commercial preservative shall be labeled as to its total content of active ingredients listed in the first paragraph.

1.4 Tests to establish conformity with the foregoing requirements shall be made in accordance with the standard methods of the American Wood-Preservers' Association.* (See Standard A2.)

2. AMMONIACAL COPPER ARSENATE (ACA)

2.1 Ammoniacal copper arsenate shall have the following composition:

Copper, as CuO	49.8%
Arsenic, as As ₂ O ₃	50.2%

subject to the tolerances listed in paragraph 2.2.

The above shall be dissolved in a solution of ammonia (NH₃) in water. The weight of ammonia contained in a treating solution shall be a minimum of 1.5 times the weight of copper expressed on the oxide basis. To aid in solution, not over 1.7 percent of glacial acetic acid may be added.

2.2 The analytical composition of the solid, paste, liquid concentrate or treating solution forms of the preservative may vary within the following limits:

	Min.*
Copper, as CuO	47.7%
Arsenic, as As ₂ O ₃	47.6%

2.3 The treating solution shall contain divalent copper and pentavalent arsenic derived from compounds in excess of 95 percent purity on an anhydrous basis.

The commercial preservative shall be labeled as to its total content of active ingredients listed in the first paragraph.

2.4 Tests to establish conformity with the foregoing requirements shall be made in accordance with the standard methods of the American Wood-Preservers' Association. (See Standard A2.)

2.5 The valency state of the arsenic component of ACA treating solutions shall be determined in accordance with Section 13 of AWPAS Standard A2, to ensure that the arsenic is in the pentavalent form.

3. AMMONIACAL COPPER ZINC ARSENATE (ACZA)

3.1 Ammoniacal Copper Zinc Arsenate shall have the following composition:

Copper as CuO	30.0%
Zinc as ZnO	25.0%
Arsenic as As ₂ O ₃	25.0%

Subject to the tolerances listed in Paragraph 3.2.

The above shall be dissolved in a solution of ammonia (NH₃) in water. The weight of ammonia

* The composition of treating solutions in use may deviate outside the limits specified in paragraphs 1.2, 2.2, 3.2, 1.2, 3.2, 6.2 and 7.2 provided: a. The preservative retention in treated material is determined by assay and the retention so determined conforms to the requirements specified in the Table of para. 3.1 in Standard C1. b. Immediate action is taken to adjust the composition of the treating solution.

* Acetic acid may be used if desired to adjust pH of treating solution to conform to paragraph 1.4.

contained in a treating solution and obtained from ammonium hydroxide, shall be at least 1.5 times the weight of copper oxide. For all solutions it is also necessary that the treating solution contain ammonium bicarbonate (NH_4HCO_3) at least equal to 0.92 times the weight of copper oxide.

3.2 The composition of the preservative present in a treating solution may vary within the following limits:

	Min. %	Max. %
Copper as CuO	15.0	15.0
Zinc as ZnO	22.5	27.5
Arsenic as As_2O_3	22.5	27.5

3.3 The treating solution shall contain bivalent copper, bivalent zinc and pentavalent arsenic derived from compounds in excess of 95 percent purity on an anhydrous basis.

The commercial preservative shall be labeled as to its total content of active ingredients listed in Paragraph 3.1.

3.4 Tests to establish conformity with the foregoing requirements shall be made in accordance with the standard methods of the American Wood-Preservers' Association.

3.5 The valency state of the arsenic component of ACZA treating solutions shall be determined in accordance with Section 13 of AWWPA Standard A2, to ensure that the arsenic is in the pentavalent form.

CHROMATED COPPER ARSENATE

4. TYPE A

4.1 Chromated copper arsenate, Type A, shall have the following composition:

Hexavalent chromium, as CrO_3	65.5%
Copper, as CuO	18.1%
Arsenic, as As_2O_3	16.4%

subject to the following tolerances:

4.2 The analytical composition of the solid, paste, liquid concentrate or treating solution forms of the preservative may vary within the following limits:

	Min., %	Max., %*
Hexavalent chromium, as CrO_3	59.4	69.3
Copper, as CuO	16.0	20.9
Arsenic, as As_2O_3	14.7	19.7

* The composition of treating solutions in use may deviate outside the limits specified in paragraphs 4.1, 4.2, 5.1, 5.2, 6.1 and 6.2 provided: a. The preservative retention in treated material is determined by assay and the retention so determined conforms to the requirements specified in the Table of para. 3.1 in Standard C1. b. Immediate action is taken to adjust the composition of the treating solution.

4.3 The solid, paste, liquid concentrate or treating solution shall be made up of water soluble compounds selected from the following groups each in excess of 95 percent purity on an anhydrous basis:
Hexavalent chromium—e.g., potassium or sodium dichromate, chromium trioxide
Bivalent copper—e.g., copper sulfate, basic copper carbonate, cupric oxide or hydroxide
Pentavalent arsenic—e.g., arsenic pentoxide, arsenic acid, sodium arsenate or pyroarsenate

The commercial preservative shall be labeled as to its total content of active ingredients listed in the first paragraph.

4.4 Tests to establish conformity with the foregoing requirements shall be made in accordance with the standard methods of the American Wood-Preservers' Association. (See Standard A2.)

5. TYPE B

5.1 Chromated copper arsenate, Type B, shall have the following composition:

Hexavalent chromium, as CrO_3	33.3%
Copper, as CuO	19.6%
Arsenic, as As_2O_3	45.1%

subject to the following tolerances:

5.2 The analytical composition of the solid, paste, liquid concentrate or treating solution forms of the preservative may vary within the following limits:

	Min., %	Max., %*
Hexavalent chromium, as CrO_3	33.0	38.0
Copper, as CuO	18.0	22.0
Arsenic, as As_2O_3	42.0	48.0

5.3 The solid, paste, liquid concentrate or treating solution shall be made up of water soluble compounds selected from the following groups each in excess of 95 percent purity on an anhydrous basis:

Hexavalent chromium—e.g., potassium or sodium dichromate, chromium trioxide
Bivalent copper—e.g., copper sulfate, basic copper carbonate, cupric oxide or hydroxide
Pentavalent arsenic—e.g., arsenic pentoxide, arsenic acid, sodium arsenate or pyroarsenate

The commercial preservative shall be labeled as to its total content of active ingredients listed in the first paragraph.

5.4 Tests to establish conformity with the foregoing requirements shall be made in accordance with the standard methods of the American Wood-Preservers' Association. (See Standard A2.)

6. TYPE C

6.1 The active ingredients in chromated copper arsenate shall have the following composition:

Hexavalent chromium, as CrO_3	47.5%
Copper, as CuO	18.5%
Arsenic, as As_2O_3	34.0%

6.2 The analytical composition of the solid, paste, liquid concentrate or treating solution forms of the preservative may vary within the following limits:

	Min., %	Max., %*
Hexavalent chromium, as CrO_3	44.5	50.5
Copper, as CuO	17.5	21.0
Arsenic, as As_2O_3	30.0	38.0

6.3 The solid, paste, liquid concentrate or treating solution shall be made up of water soluble compounds selected from the following groups each in excess of 95 percent purity on an anhydrous basis:

Hexavalent chromium—e.g., potassium or sodium dichromate, chromium trioxide
 Bivalent copper—e.g., copper sulfate, basic copper carbonate, cupric oxide or hydroxide
 Pentavalent arsenic—e.g., arsenic pentoxide, arsenic acid, sodium arsenate or pyroarsenate

The commercial preservative shall be labeled as to its total content of active ingredients listed in the first paragraph.

6.4 Tests to establish conformity with the foregoing requirements shall be made in accordance with the standard methods of the American Wood-Preservers' Association. (See Standard A2.)

7. CHROMATED ZINC CHLORIDE (CZC)

7.1 Chromated zinc chloride shall have the following composition:

Hexavalent chromium, as CrO_3	20%
Zinc, as ZnO	80%

subject to the following tolerances:

7.2 The analytical composition of the solid, paste, liquid concentrate or treating solution forms of the preservative may vary within the following limits:

	Min., %*
Hexavalent chromium, as CrO_3	19
Zinc, as ZnO	76

7.3 Samples of chromated zinc chloride treating solution taken from a working tank or treating cylinder may show changes in composition as a result of treating operations. Such changes shall not serve to cause rejection of the preservative if they do not raise the ratio of zinc oxide to chromium trioxide to more than 7 to 1, and if it can be shown that the

original fresh preservative was of the specified composition.

7.4 The solid, paste, liquid concentrate or treating solution shall be made up of water soluble compounds selected from the following groups each in excess of 95 percent purity on an anhydrous basis:

Hexavalent chromium—e.g., sodium dichromate, chromium trioxide
 Zinc—e.g., zinc chloride

The commercial preservative shall be labeled as to its total content of active ingredients listed in the first paragraph.

7.5 Tests to establish conformity with the foregoing requirements shall be made in accordance with the standard methods of the American Wood-Preservers' Association. (See Standard A2.)

8. ALKYL AMMONIUM COMPOUND (AAC)

8.1 Alkyl ammonium compound shall have the following composition:

Didecylidimethylammonium chloride
 90% min.

Dialkylidimethylammonium chlorides
 (containing C8 or C12)

10% max.
 8.2 The liquid concentrate shall be made up in lower (<C4) alcohols and/or water such that the active ingredient is freely soluble in water.

The commercial preservative shall be labeled as to its total content of active ingredients listed in the first paragraph.

9. INORGANIC BORON

9.1 Sodium Borate

9.2 Sodium borate shall have the following composition:

Boron, as B_2O_3	67%
Sodium, as Na_2O	15%

Subject to the following tolerances:

9.3 The analytical composition of the solid, paste, liquid concentrate or treating solution forms of the preservative may vary within the following limits:

	Min., %	Max., %
Boron, as B_2O_3	35	75
Sodium, as Na_2O	10	24

9.4 The solid, paste, liquid concentrate or treating solution shall be made up of water soluble compounds selected from the following groups each in excess of 95 percent purity on an anhydrous basis:

Boron—e.g., sodium octaborate, sodium tetraborate, sodium pentaborate, boric acid + sodium tetraborate

* The composition of treating solutions in use may deviate outside the limits specified in paragraphs 1.2, 2.2, 3.2, 4.2, 5.2, 6.2 and 7.2 provided: a. The preservative retention in treated material is determined by assay and the retention so determined conforms to the requirements specified in the Table of para. 3.1 in Standard C1. b. Immediate action is taken to adjust the composition of the treating solution.

AMERICAN WOOD-PRESERVERS' ASSOCIATION
STANDARD

(This Standard is under the jurisdiction of AWWA Committee P-3)

P8-89

STANDARDS FOR OIL-BORNE PRESERVATIVES

1. PENTACHLOROPHENOL

1.1 Pentachlorophenol shall contain not less than 95 percent of chlorinated phenols as determined by titration of hydroxyl and calculated as pentachlorophenol.

1.2 It shall contain not more than 1 percent of matter insoluble in N/1 aqueous sodium hydroxide solution.

1.3 It shall have a freezing point of not less than 174°C.

1.4 The foregoing tests shall be made in accordance with the standard methods of the American Wood-Preservers' Association. (See Standard A5).

1.5 Solvents used to prepare solutions of pentachlorophenol shall comply with the standards of the American Wood-Preservers' Association (See Standard P9)

2. COPPER NAPHTHENATE

2.1 The naphthenic acid used in the manufacture of copper naphthenate shall be of the group of alicyclic carboxylic acids occurring in petroleum and shall have an acid number of not less than 180, on an oil-free basis.

2.2 The copper naphthenate concentrate used to prepare wood-preserving solutions shall contain not less than 6 percent nor more than 8 percent copper in the form of copper naphthenate.

2.3 All of the copper present in the concentrate shall be combined as copper naphthenate.

2.4 The copper naphthenate concentrate shall not contain more than 0.5 percent water.

2.5 The foregoing tests shall be made in accordance with the standard methods of the American Wood-Preservers' Association.¹ (See Standard A5)

2.6 Solvents used to prepare solutions of copper naphthenate shall comply with the standards of the American Wood-Preservers' Association. (See Standard P9)

3. SOLUBILIZED COPPER-8-QUINOLINOLATE

3.1 Solubilized Copper-8-Quinolinolate shall have the following composition:

Copper-8-quinolinolate, wt., min.	10.0%
Nickel-2-ethylhexoate, wt., min.	10.0%
Inert ingredients (hydrocarbon solvents), wt., min.	80.0%
	100.0%

Physical Properties

Copper as metal, wt., min.	1.80%
Nickel as metal, wt., min.	1.80%
pH	5.5-6.5
Specific gravity at 77°F.	0.935-0.975

Solubility—Completely soluble in aliphatic and aromatic solvents which comply with the standards of the American Wood-Preservers' Association.

3.2 Solubilized copper-8-quinolinolate should be free of amines, phosphoric acid, or naphthenic acid and its derivatives.

4. BIS(TRI-N-BUTYLTIN) OXIDE

4. Bis(tri-n-butyltin) oxide, commonly called TBTO², shall have the following composition:

4.1 TBTO shall have the following composition: Bis (tri-n-butyltin) oxide, wt. min.—95%; Tin as metal, wt. min.—38.2%; wt. max.—40.1%.

4.2 TBTO shall be a colorless to slightly yellow liquid.

4.3 The solvent employed in formulating the preservation solution shall meet the requirements of Hydrocarbon Solvent Type C, Standard P9, Par. 3.1.

5. ALKYL AMMONIUM COMPOUND (AAC)

5.1. Alkyl ammonium compound shall have the following composition:

Didecylidimethylammonium chloride 90% min.

Dialkylidimethylammonium chlorides (containing C8 or C12)..... 10% max.

5.2. The liquid concentrate shall be made up in lower (C4) alcohols and/or water such that the active ingredient is freely soluble in water.

The commercial preservative shall be labeled as to its total content of active ingredients listed in the first paragraph.

¹ Methods are being prepared for determining conformity with pars. 2.1 and 2.5.

² Trademark M&T Chemical Co.

**AMERICAN
WOOD-PRESERVERS'
ASSOCIATION**

**STANDARDS
1989**

1967. As a rule, however, preservative intake is insufficient to provide adequate protection for ground contact uses, except in easily penetrated woods such as pine *Hunt and Garratt, 1967; Gjovik and Baechler, 1976*. Cold soaking has been widely promoted for treating fence posts for farm use *Hunt and Garratt, 1967; Gjovik, 1976*.

6.2.3.5 Dipping. The process involves short term immersion in oil-type preservatives, commonly penta dissolved in a low-boiling solvent. Dipping is used to a much greater extent than long-term immersion (cold soaking). Its primary use is for pre-cut sash and frames, and millwork that will be used under very mild decay conditions. Although penetration across the grain is negligible, penetration into the cut ends of absorbent wood may be appreciable. Therefore, the wood should be trimmed before use as trimming would remove much of the preserved wood and expose untreated wood *Gjovik, in press*.

6.2.3.6 Brushing or Spraying. These treatments consist of application of preservative to the surface of the wood.

They are most effective on cut surfaces since end grain absorb liquid more readily than does side grain. All classes of preservatives are used, though creosote and oil-borne preservatives predominate. Such treatment may add one to three years to the life of a wood product *Hunt and Garratt, 1967*. Preservatives in paste or grease form are also used since greater amounts of preservative are retained on the wood surface. Pastes are widely used for groundline treatments of standing poles and other "in place" applications *Hunt and Garratt, 1967; Gjovik, 1976*.

6.2.3.7 Double Diffusion. This process is a modification of the one stage diffusion process in which wood is treated successively with solutions of two chemicals which react with each other within the wood, producing an insoluble precipitate. The result is a preservative that is extremely resistant to leaching. Results with pines and some other conifers have been excellent, comparing well with pressure treatments. The method has not been widely promoted and is not in common use in the United States *Gjovik, 1976*.

Table 6-10
AWPA SPECIFICATION P5 FOR WATERBORNE PRESERVATIVES

PRESERVATIVE COMPONENT	ACC	ACA	CCA			CZC	FCAP
			TYPE A	TYPE B	TYPE C		
Copper as CuO	28.0' 31.9'	47.7 49.8	18.0- 20.9 18.1	18.0- 22.0 19.6	17.0- 21.0 19.5	-	-
Hexavalent chromium as CrO ₃	63.3 68.2	-	59.4- 69.3 65.5	33.0- 38.0 35.3	44.5- 50.5 47.5	19.0	33.0- 41.0
Arsenic as AS ₂ O ₅	-	47.8 50.2	14.7- 19.7 16.4	42.0- 48.0 45.1	30.0- 38.0 34.0	-	22.0- 29.0
Zinc as ZnO	-	-	-	-	-	78.0 80.0	-
Fluoride as F	-	-	-	-	-	-	20.0- 24.0 22.0
Dinitrophenol	-	-	-	-	-	-	14.0- 18.0 16.0
pH of Treating solution	2.0-3.9	Not Applicable	1.6-3.2	1.6-3.0	1.6-3.0	2.8-4.0	5.5-7.8

1. Upper number is minimum content, in percent of the solid preservative. Two numbers indicate extreme allowable range (minimum and maximum).
2. Lower number is defined content, in percent of the solid preservative.

Source: American Wood-Preservers' Association (1974a).

U.S. patents covering aspects of its use date back to 1918. One form was accepted by the AWP in 1944 *Hartford, 1973*. FCAP consists of sodium fluoride, sodium chromate or dichromate, and sodium arsenate, plus either dinitrophenol or sodium pentachlorophenolate. Like CZC this preservative is somewhat leachable and is therefore used primarily for treatment of lumber which is not intended for use under severe leaching conditions *Hartford, 1973; Gjovik, 1976*.

1.1.4 Physical Methods of Preservation

Stamm 1964 describes several techniques that may be used to produce decay resistance in wood without toxic chemicals. These include various dimension stabilizing agents which significantly reduce the hygroscopicity of the wood. Decay resistance was demonstrated for some situations following heating, either in the presence or absence of salt catalysts; treatment with a fiber-penetrating phenol-formaldehyde, resin-forming mix; acetylation; cross linking with formaldehyde; and treatment with polyethylene glycol-1000. These treatments were effective provided that they reduced the swelling and shrinking of the wood by between 40 and 70 percent. None of these treatments are presently subject to extensive use. They will be discussed further in the sections dealing with chemical alternatives.

6.2 Application Methods

The method by which preservatives are impregnated into wood is nearly as important in determining the treatment effectiveness as the type of preservative used. The desired characteristics of a good application method are an ability to secure a deep and reasonably uniform penetration with a preservative retention appropriate to the ultimate end use of the product. For some purposes such as window sash and millwork, adequate preservation can be accomplished through the use of relatively cheap, non-pressure processes such as dipping, steeping and brush and spray treatments. For most commercial and industrial purposes, however, adequate protection requires the use of pressurized processes designed to force the preservatives into the wood.

Table 6-11 provides a comparison of the relative volumes of wood treated by pressure and non-pressure processes. It must be noted, however, that data presented in this table may be somewhat biased to favor the pressure treating processes since it was based on the results of pools of the wood preserving industry. Since non-pressure treatment does not require extensive equipment, and is more commonly used by small operations such as lumberyards and individual homeowners, there have probably been significant omissions in the total volume of non-pressure treated wood.

Table 6-11
WOOD MATERIAL TREATED IN 1975 BY PRESSURE AND NONPRESSURE PROCESSES BY
REGION, AND UNITED STATES TOTAL 1974 AND 1975
(THOUSAND UNITS)

END USES	TREATMENT	REGION						TOTAL U.S.	
		NORTHEAST	NORTH CENTRAL	SOUTHEAST	SOUTH CENTRAL	ROCKY MOUNTAIN	PACIFIC	1974	1975
POLES (Number)	Pressure	45	109	929	1,132	116	346	4,321	2,726
	Nonpressure	0	58	0	0	101	53	241	212
CROSSTIES (Number)	Pressure	2,982	8,269	4,341	8,674	1,979	1,640	23,885	27,884
	Nonpressure	0	0	0	0	0	0	0	0
LUMBER AND TIMBERS (Board feet)	Pressure	49,393	70,483	288,366	292,568	17,660	151,337	970,310	869,807
	Nonpressure	0	1,097	0	651	480	0	2,979	484
FENCE POSTS (Number)	Pressure	173	1,416	5,147	14,534	528	181	26,504	21,979
	Nonpressure	26	229	141	86	3	0	383	64
PILING (Linear feet)	Pressure	2,610	510	4,353	5,861	37	2,484	22,289	15,860
	Nonpressure	64	0	0	0	0	0	0	64
SWITCH TIES (Board feet)	Pressure	12,752	32,385	14,415	25,472	7,577	2,086	77,650	95,186
	Nonpressure	0	250	0	0	0	0	571	250
CROSSARMS (Number)	Pressure	190	141	319	205	0	508	2,489	1,363
	Nonpressure	0	0	0	0	0	473	1	473
PLYWOOD (Square feet)	Pressure	3,510	4,159	8,886	6,574	1,045	17,321	46,866	41,495
	Nonpressure	0	106	0	0	0	0	155	106
OTHER (Cubic feet)	Pressure	390	898	785	1,242	415	691	6,533	4,421
	Nonpressure	0	22	0	0	4	13	167	38

Note: Components may not add up to totals due to rounding.

Source: Ernst and Ernst (1976).

Most of this wood would fall into the lumber and post categories.

The following sections give a brief discussion of the major types of processes.

6.2.1 Seasoning

Although a few treatment processes may produce good results when applied to green timber, most commercial treatments commonly used in this country require some sort of pretreatment in order to sterilize the wood and to remove as much moisture as is feasible. Such treatments have a significant effect on the service life of the wood. Improperly seasoned wood may be subject to failure soon after emplacement while correctly seasoned wood of the same species and subject to the same preservative retentions may have a service life of 25 or more years. Seasoning techniques employed today include *Hunt and Garratt, 1967*: air seasoning, steaming and vacuum, vapor drying, kiln drying, and boiling in oil at atmospheric pressure or under a vacuum (Boultonizing). The seasoning method employed depends on the species of wood and the preservative to be used. For instance, Boultonizing is used primarily for Douglas fir poles and timbers (and to a lesser extent for oak piles and timbers), which are to be treated with creosote or oil-borne preservatives *Henry, 1973*. Southern pine products may be conditioned by several methods, of

which air seasoning and steam conditioning are the most common. Steaming is a rapid seasoning method which may be employed in the pressure cylinders used to apply the preservatives. Due to resultant severe wood damage, the steaming of Douglas fir is not permitted. Steam treatment is used prior to treatment with either creosote, creosote solutions, or oil-borne preservatives. Wood that is to be treated with waterborne preservatives is usually air seasoned, or, if storage space is at a premium, kiln dried. Southern pine poles may be subject to fungal attack and incomplete drying when air seasoning is employed *Arsenault, 1973*. Therefore, this method is often reserved for products such as ties which dry more easily due to their cut surfaces. The various conditioning processes are described in much greater detail by *Hunt and Garratt 1967*, *Arsenault 1973*, and *Henry 1973*.

Mechanical preparations may also be required in order to facilitate impregnation of the preservative into the wood. They may include: peeling, shaving, adzing, boring, framing, and/or incising. These are also discussed in detail by *Hunt and Garratt 1967*.

6.2.2 Pressure Processes

Pressure processes are the predominant methods used in the commercial treatment of wood. The distinguishing features of such methods are that the

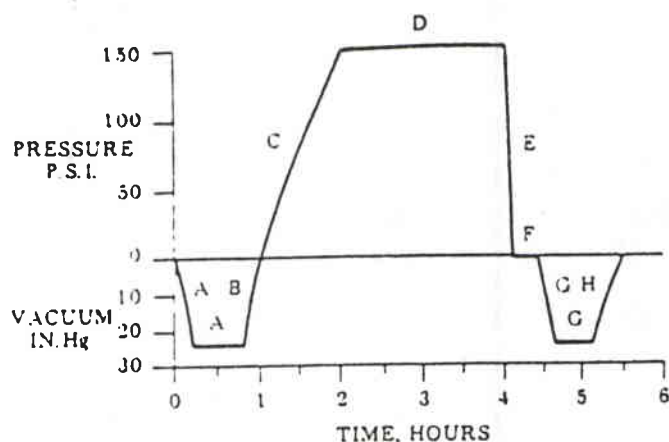
wood is enclosed in a sealed cylinder, submersed in a liquid preservative and subjected to hydrostatic pressure. Principal advantages of pressure processes include the achievement of a deeper and more uniform preservative penetration in many species, better control over preservative retention, suitability for large-scale production of treated material, ability to precondition wood in the pressure cylinder, and generally shorter time requirements than non-pressure process. Principal disadvantages are the amount and cost of the required equipment, and the increased transportation costs resulting from the necessity of shipping timber to the treatment plant.

There are two basic procedures for pressure treating wood. The full-cell process is designed to achieve maximum retention of liquid in the wood by filling the wood cells. The empty-cell process is designed to achieve the same depth of penetration, with lower retentions by merely coating the walls of the wood cells. Neither process actually leaves the cells completely empty full, but the names full-cell and empty-cell are good descriptions of the basic theory behind the two procedures.

6.2.2.1 Full-Cell Process. The full-cell process is commonly used with aqueous solutions. The preservative retention is controlled by the concentration of the solution. Full-cell treatments are also employed with creosote for marine piling and timbers or other special applications where maximum preservative retentions are required.

The distinguishing feature of full-cell treatment is the application of an initial vacuum. After the wood is sealed within the cylinder, a minimum vacuum of 22 inches of mercury is drawn and held for between 15 minutes and one hour. During this time any air or water that may be held in the outer layers of the wood is forced out. Then, without releasing the vacuum, preservative solution is introduced into the cylinder. This solution is usually hot: 180° to 210°F for oil solutions, and 120° to 150°F for aqueous solutions, although treatment with waterborne salts may also be performed at ambient temperatures *Burdell, 1977*. When the cylinder is completely filled with the preservative solution, additional solution is added so as to create pressure and force the solution into the wood. The pressure usually ranges from 125 to as much as 200 psi. It is maintained to the point of refusal, at which the quantity of preservative absorbed in each of two consecutive half hours is equal to or less than two percent of the solution already injected. At that point the pressure is released, preferably slowly, and the solution is returned to the storage tank. A short final vacuum is sometimes applied to dry the surface of the timber. A final vacuum is a common feature in the treatment of dry southern pine *Hunt and Garratt, 1967; Henry, 1973*.

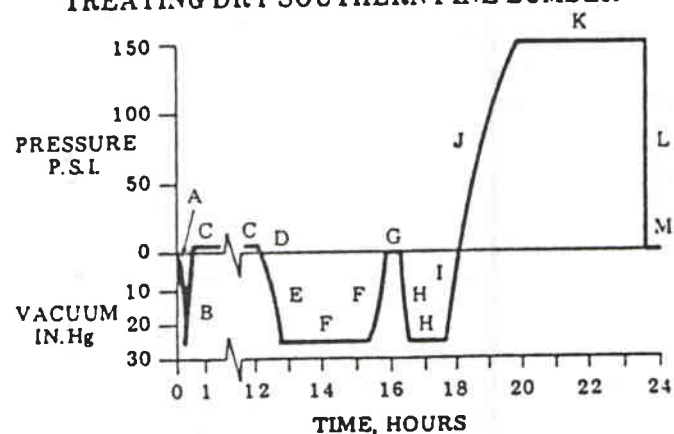
Green wood may be pre-treated by the addition of steaming and vacuum steps to the beginning of the process. Figure 6-1 shows the typical treating cycles for pressure treatment with the full-cell method with a final vacuum; Figure 6-2 shows a typical cycle for the full-cell method preceded by steam pretreatment; and Figure



- A. PRELIMINARY AIR PRESSURE APPLIED
- B. FILLING CYLINDER WITH PRESERVATIVE
- C. PRESSURE RISING TO MAXIMUM
- D. MAXIMUM PRESSURE MAINTAINED
- E. PRESSURE RELEASED
- F. PRESERVATIVE WITHDRAWN
- G. FINAL VACUUM
- H. VACUUM RELEASED

Source: Henry (1973).

Figure 6-1
TYPICAL FULL-CELL TREATING CYCLE USED FOR
TREATING DRY SOUTHERN PINE LUMBER

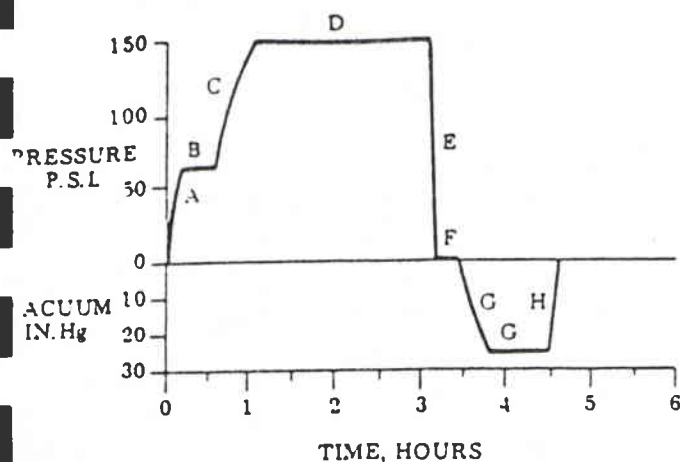


- A. PRE-STEAM VACUUM
- B. STEAM INTRODUCED
- C. STEAM MAINTAINED
- D. STEAM RELEASED
- E. POST-STEAM VACUUM
- F. VACUUM RELEASED
- G. CONDENSATE DRAINED
- H. PRELIMINARY VACUUM PERIOD
- I. FILLING CYLINDER WITH PRESERVATIVE
- J. PRESSURE RISING TO MAXIMUM
- K. MAXIMUM PRESSURE MAINTAINED
- L. PRESSURE RELEASED
- M. PRESERVATIVE WITHDRAWN

Source: Henry (1973).

Figure 6-2
TYPICAL FULL-CELL TREATING CYCLE USED FOR
TREATING GREEN SOUTHERN PINE PILES

6-3 shows a typical cycle for the empty-cell (Rueping) process (see following discussion of empty-cell processes).



- A. PRELIMINARY VACUUM
- B. FILLING CYLINDER WITH PRESERVATIVE
- C. PRESSURE RISING TO MAXIMUM
- D. MAXIMUM PRESSURE MAINTAINED
- E. PRESSURE RELEASED
- F. PRESERVATIVE WITHDRAWN
- G. FINAL VACUUM
- H. VACUUM RELEASED

Source: Henry (1973).

Figure 6-3
TYPICAL EMPTY-CELL TREATING CYCLE USED FOR
TREATING DRY SOUTHERN PINE POLES

The full-cell process is used most commonly for treatment of Douglas fir and southern pine with 1 to 4 percent solutions of aqueous salts Henry, 1973. Southern pine has a cellular structure which allows rapid absorption of solution and can withstand more rapid changes in pressure than that of Douglas fir. Consequently, pressure changes must be carried out more slowly when treating Douglas fir.

6.2.2 Empty-Cell Process. There are two major variations of the empty-cell process. In the Rueping process, the treating cylinder is pressurized after being loaded with wood, but before any preservative is admitted. The pressure used varies depending on the character of the wood, particularly the species and moisture content; and on the desired net retention of the preservative. The preservative is added to the cylinder without releasing the pressure, thus trapping compressed air in the pores within the wood. The preservative is then driven into the wood by increasing the pressure. When the desired absorption has been obtained, the pressure is released. As the pressure falls, preservative is forced out of the wood by expansion of the compressed air. Immediately following this, a vacuum is applied to the cylinder to accelerate the recovery of oil. The net retention of preservative is the difference between the total injected (gross absorption) and the oil recovered

(kickback). The Rueping process is probably the most widely used process for treatment of poles, land piles, posts, crossties, and lumber with creosote or oil-borne preservatives Henry, 1973.

The Lowry process is similar to the Rueping except that no initial pressure is applied. After loading the wood, the cylinder is filled with preservative under atmospheric pressure. Pressure is then applied and the process continues in the same manner. This method requires essentially no more equipment than is needed by the full-cell process.

Empty-cell methods are useful for providing as deep a penetration as possible, while limiting total preservative retention, thus providing well protected, relatively clean (non-bleeding) products at more economical prices than the full cell methods. A final steaming step is often used to promote surface cleanliness Henry, 1973. Such methods may also be used for application of aqueous preservative solutions when the treatment is to be immediately followed by the injection of an oily preservative (dual treatment); or in order to minimize the product weight if it is to be shipped before it is dried Hunt and Garratt, 1967; Gjovik, 1976.

6.2.2.3 Treatment with Volatile Solvents. There are several processes which have been recently developed to impregnate wood with pentachlorophenol using a volatile solvent. These usually employ the full-cell pressure method, though the empty-cell process may also be employed using a noncombustible gas such as nitrogen to apply the initial pressure U.S. Department of Agriculture, 1974a. After impregnation, the solvent is evaporated by decreasing the pressure within the cylinder or by introducing water and heating it to boiling. The preservative remains deeply impregnated in the wood while the solvent is recovered for reuse. Such processes have the advantage that due to the low viscosity of the solution, they generally require shorter times to achieve the same penetration as conventional treatments. These processes include the Cellon® process, using liquified petroleum gas (LPG-AWPA standard P9 type B); the Dow® process, using methylene chloride (AWPA standard P9 type D); and several variants of these, including processes which employ a light solvent treatment (LST) conforming to AWPA standard P9 type C Marouchoc, 1972; Henry, 1973; Ochrymowych and McOrmond, 1975.

6.2.3 Non-Pressure Processes

Many different types of non-pressure processes have been utilized for treating wood. The most commonly used methods for treatment of lumber, piling and posts consist of various combinations of dipping, soaking, and steeping wood in hot and/or cold preservative baths. Brush and spray treatments are used on wood that is already part of a structure.

The effectiveness of non-pressure processes depends to a large extent on the properties of the wood. The pathways by which liquids enter soft wood timber are the tracheids and resin ducts in the longitudinal (along

the grain) direction and the parenchyma and radial resin ducts in the lateral (across the grain) direction. The characteristics of these pathways vary widely among different species of wood, resulting in a wide range of treatabilities. This subject will be discussed in more detail in Appendix B.

Next to wood species, the most important factor in determining the effectiveness of a non-pressure treatment is the moisture content of the wood *Hochman, 1971*. When dry wood is immersed in an aqueous solution, the outer layers of the wood rapidly absorb the solution and swell in size, constricting the inner fluid pathways and rapidly retarding the rate of absorption of the liquid *Gjovik, 1976*. It has also been reported that penetration of air and kiln dried wood by dilute aqueous solutions is greater than the penetrations obtained using concentrated treating solutions. The depth of penetration was greatest at 20 percent moisture content and was severely inhibited at moisture content well above the fiber saturation* (greater than 50 percent) *Hochman, 1971*.

These results indicate that the primary driving force of non-pressure application methods is the process of diffusion. Although capillary action and thermal expansion and contraction are also used to advantage by some methods. In an ideal diffusion process the depth of penetration is proportional to the square root of the length of the treatment period and the concentration of solute in the wood is proportional to the concentration in the treating solution. Due to non-ideal conditions these relationships are only approximated in the application of wood preservatives.

6.2.3.1 Thermal Process. The thermal process, also known as the hot-and-cold process, is the most important non-pressure process for treating wood for ground contact use in this country. It is the only process covered by the specifications of the AWP and Federal Government *General Services Administration, 1968*; *Gjovik, 1976*. The process consists of immersing air seasoned or kiln dried products successively in baths of hot and relatively cool liquid preservatives. Both preservative oils and water soluble salts may be used, although use of aqueous solutions poses additional technical constraints and is not regularly practiced at present. The hot bath used with creosote or penta solutions is typically held at 200° to 235° F for at least six hours *Hunt and Garratt, 1967*. The hot preservative expands the air in the outer layers of the wood, causing some of it to be expelled. The immediate introduction of the relatively cold preservative (typically 100° F for two hours) causes the remaining air and water vapor to contract, forming a partial vacuum within the wood. Atmospheric pressure forces preservative into the wood to satisfy the vacuum. In some cases, particularly where a clean product is desired, the wood is resubjected to the

hot bath for a short period of time (on the order of thirty minutes) *Hunt and Garratt, 1967*. This action removes excess preservative while maintaining adequate penetrations, thereby reducing bleeding tendencies without sacrificing protection *Henry, 1973*; *Gjovik, 1976*.

This process is an effective resistant to impregnation *Farmer, 1973*. Approximately half of the poles treated by the thermal process are of western red cedar, a thin-sapwood species with a naturally durable heartwood. Other species treated in this manner include Douglas fir, western larch, and lodgepole pine *Gjovik, 1976*. The thermal process is also widely used for the preservation of timber on farms in rural areas *Farmer, 1973*.

6.2.3.2 Vacuum Process. This process produces results similar to those of the thermal process through the use of an initial vacuum. The preservative is added and the vacuum released. The preservative is driven into the wood by the pressure difference between the initial vacuum and atmospheric pressure, usually about one half to two-thirds of an atmosphere. Frequently, a final vacuum is applied to control the preservation retention and recover excess solution. In one modification, the final vacuum is higher than the initial vacuum. Release of the second vacuum causes further penetration of the preservative into the wood *Henry, 1973*.

The vacuum method is particularly suitable for application of low-viscosity organic solvent preservatives to easily treatable woods *Gjovik, 1976*. The most commonly used preservative is penta plus a water repellent material dissolved in a light petroleum solvent. Its use is primarily for exterior joinery timber, lumber and millwork *Hunt and Garratt, 1967*; *Farmer, 1973*.

6.2.3.3 Steeping. Steeping involves submerging wood in a tank of waterborne preservative for periods of between several days and several weeks. The solution is usually left at ambient temperatures, though preservative uptake could be somewhat enhanced by heating the solution *Hunt and Garratt, 1967*. The mechanism by which the preservative is absorbed by the wood depends on whether or not the wood is seasoned before treatment. Seasoned timber absorbs both the water and the preservative in solution by capillary action. Since very little additional water can be absorbed by green timber the preservative penetrates the wood by diffusion. The amount of preservative absorbed by the wood depends on the length of time the wood is left in the solution. However, with long steeping times, absorptions are generally low, on the order of 1/8 to 1/4 inch. In order to improve the uptake of preservative, the treating solutions are generally more concentrated than those with pressure processes *Hunt and Garratt, 1967*.

6.2.3.4 Cold Soaking. This method is similar to steeping, except that it utilizes an oil-borne solution of preservative, most commonly pentachlorophenol. Immersion periods of two days to one week or more are desirable. The mechanism of absorption is by capillary movement. Absorption of four to six lbs. of solution per cubic foot is achievable in well-seasoned wood *Hunt and Garratt,*

*Fiber saturation is defined by *Hunt and Garratt 1967* as the point at which the cell cavities are considered to be devoid of moisture while the walls are fully saturated. This point occurs at 25 to 30 percent moisture content for most temperature-zone woods.